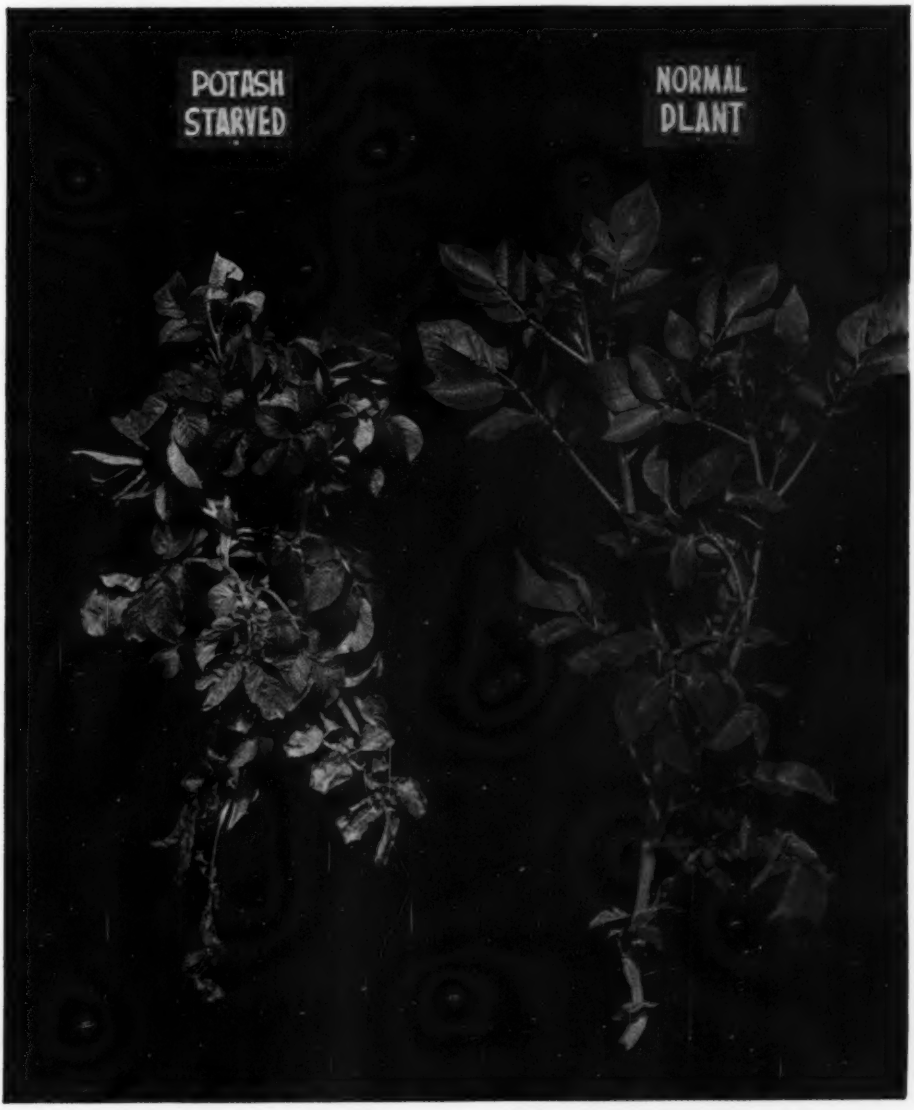
Better Crops WITH PLANT FOOD

November, 1957 10 Cents



". . . but don't wait for the signs to appear . . ."

grow quality with POTASH!

You name the row crop—and you'll find that it grows better, produces more, brings higher prices, when it is supplied with plenty of *available* Potash.

Nature can go only so far in providing vitally needed Potash. Fast-growing, high-producing crops can easily exhaust the available soil supply—and then it's up to you. That's why it's good business to be sure your fertilizer program includes plenty of POTASH—either in your mixed fertilizers or as a supplemental application.

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ON THE COVER . . .

. . . We see the sharp contrast between a potash-starved potato plant and a normal plant.

The potash-starved potato plant, on the left, came from a Michigan Muck Experimental Field that was fertilized with phosphate alone—or 0-20-0 fertilizer.

The normal plant, right, came from a plot that received 1,000 lbs. of 0-10-30 fertilizer.

Potash hunger in your potato plants can be detected by certain unmistakable signs:

1—Appearance of abnormally dark green foliage. This is one of the earliest signs of potash hunger in your potato plants.

2—Retarded growth. Look at the starved plant here. Notice the internodes. They are somewhat shortened, giving the plant a compact look.

3—Smaller leaves. Notice the narrow arrangement of the leaves which form a sharp angle with the stem. The leaves have lost their smooth surface. They are crinkled, and they droop.

4—Later, older leaves turn yellowish. A brown or bronze color develops, starting from the tip and edge and gradually covering the entire leaf, which finally dies. In just one plant, this bronzing is not too noticeable, but when your whole field starts getting in that shape the condition becomes prominent.

5—Lower leaves eventually dry up. This leaves a tuft of dark green leaves at the top of the plant. And eventually the whole plant dies.

All these signs are evident in the potato plant on the left side of this cover. *But don't wait for these signs to appear.* If you do, much of your potato crop will be lost—in yield and quality.

Potatoes are greedy feeders on potash. They use more of this plant food than nitrogen and phosphoric acid combined. To grow a good crop of No. 1's, soil and fertilizer must supply at least 200 lbs. of available potash (actual K_2O) per acre.

Better Crops with PLANT FOOD

The Whole Truth
Not Selected Truth

SANTFORD MARTIN, *Editor*

Editorial Office:
1102 16th Street, N. W.
Washington 6, D. C.

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"Which one, Mama?"

Better Crops with PLANT FOOD

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VOL. XLI WASHINGTON, D. C., NOVEMBER 1957 No. 9

Farming owes much to . . .

OFFICERS IN OVERALLS

Jeff McDermid

(ELWOOD R. MCINTYRE)

REMEMBER the first County Agricultural Agent?

In my state he drove a dusty old Ford car, loaded to the gunwales with soil augers and soil samples, wire seed corn dryers, packets of litmus paper, rag-doll testers, dairy barn record sheets, caustic potash and nippers for calf and cow dehorning, dynamite sticks for ditch and stump blasting, drain tile samples, spray guns, balanced feed guides, hip boots, formaldehyde, college bulletins, and handy plans for bull pens and split-log road drags.

No wonder many farmers put him in the same class with itinerant wanderers—such as lay preachers, tinware and notion peddlers, liniment and flavoring extract salesmen, as well as the ubiquitous lightning-rod specialist.

And the word "agent" didn't always help to clear the air either.

That was about six years after Dr. Knapp hired his demonstrators in farm management and insect control, which laid the foundation in Texas for what has since blossomed into a far-flung, many-sided and complex institution of state and federal education.

Iowa's pioneer extensioners—Holden and Bliss—with their corn clubs and exhibit trains belong in the same period; and in Ohio A. B. Graham was laying a strong foundation, also, for general extension, with 4-H clubs in particular. Today the farmer and his family are a real part

of the extension force themselves—but in those formative times they just looked on *and doubted.*

Today, after a half century of circuit riding and making converts, our country agricultural advisors head a large network of farm services. They are as far removed from the original models as the sleek modern motor car is from the battered old travel contraption of a bygone era of slow motion and poor roads.

Our astounding, prolific production has accompanied the rise of the county agent system. Farmers have risen to a new life with improved seed, better soil conservation practices, multi-machinery power, scientific stock feeding, management and sanitation, conquest of plant diseases and insect ravages, and by hard work and hard thinking, careful planning and usually favorable weather.

Lonely guesswork and drudgery, with lean returns at best, have been replaced with modern equipment, better income and household conveniences on our upper level farms. It has been done mainly by education that reaches rural workers via radio, television, farm journals, newspapers, and extension meetings.

To help do a similar job for farm folks with less opportunities, an allied agency has been developed with considerable popular support, known as the Rural Improvement Program.

This kind of education sold itself. It needed no decrees or ukases to get it going well. The Smith-Lever Act of 1914 laid the basis for the extension formula. In a year or two an amendment challenged each cooperating state to put up matching funds above and beyond the original grant of $10,000 in federal aid to each state.

"WHEN EDUCATION IS UPPERMOST . . .

Hence we enjoyed a local option process. There was no force, no threats of reprisal or political interference. Any state might do as it desired with the new farmers' aid program—take it or leave it. Each county, likewise, could use its own judgment and either add another fellow to the courthouse crowd or laugh it off as an "expense we can do without."

Oh, yes, it was not all easy driving on smooth roads. We had our share of vigorous objectors and fun-pokers. Book farming and stuffy professors, the insidious influence of big business, and the useless expense of keeping another paid employee down in the basement next to the coal bins to hand out circulars nobody ever read—such were common-run sentiments we all heard spoken in the 1910-20 era.

Interesting enough, a considerable quota of the worst grumblers in the community finally got to spending most of their leisure hours down in the stone-walled basement. The county agent just "drafted" them as "leading farm owners" to map out his first courses of action. When *education* is uppermost in a program, the opposition usually fades away or is swept up with the tide.

Folks found they were welcome to speak out in meetings at any time on the county extension programs. Freedom of personal opinion lent

savor to the sauce. The county agent who had no outspoken critics began to worry. He preferred a hot debate and a little hostile notice to silence and forgetfulness. In true American style, no program could be accepted without careful trial and test. A plan that dodges criticism seldom deserves to last.

Far be it from me to gloss over mistakes that have been made in adapting such traveling teachers to the open country. We made plenty, and we make them yet. I know a few of the early county agents were time-servers and weak-sisters, and a few of them were moral scalawags who got quick dismissal. But I can whack the typewriter in pride because *99 percent* of the county agents and extension specialists in my field of vision have done *far more for others than for themselves.* A few more of them spent so much time and long hours away from home that they injured their health and left the family neglected. They were on a mission —so great, so good, so prophetic that we eat food, wear clothes, live under roofs today unequalled in mankind's long search for The Promised Land.

Back in the days when the county agent had to open his bag of tricks on each farm to gain attention and support, he was merely doing *personal service jobs.* I have heard the veterinarians complain about the county agents butting into his profession. I have heard country merchants criticize the county agent for recommending home-mixed feeds and minerals when the store shelves were loaded with ready-mixed preparations.

All that is past—and how! I don't suppose a county agent in my state has prepared a completely home-grown stock ration since antibiotics

. . . OPPOSITION USUALLY FADES AWAY"

and hormones came along. Today the civic clubs who meet each week for a rousing gabfest almost always have the county agent on the executive committee. With the rise of research and its information that farmers get so quickly, town and county are associated in business means and motives—and the county agent becomes the actual *representative of both.* Maybe "agribusiness agent" would be a better and more applicable term, in view of his widening clientele.

Had there been no trail blazed by county extension methods for 40 years, the success of the many new agencies enlisted in the various newer programs would have been less effective and lasting. It was simpler to follow a beaten path than to push through blindly. The extension system, in all probability, will out-last most of them.

Yet, county agents are in the midst of an adjustment, as are all workers close to the modern farm of changing character. Farms grow in acreage while numbers of employed farmers decline.

This theme of change and adjustment was the keynote of the 1957 Annual County Agents Convention in Boston. Like vo-ag teachers, county agents see the countryside growing less populous with individuals. The goal now seems to be one of building closer relations with these

"elite" individuals who still farm. Some county agents are working largely with city or town people.

Maybe our farm destiny rests on the dwindled ranks of active farmers. Maybe if we can reach and teach them more intensely, and also do something for the farm boys who cannot farm for want of opportunity, maybe there lies in this situation a stronger role for county agents (and vo-ag teachers).

More and more of our communities are finding themselves a real part of the agribusiness picture. We are forced to adjust—even to township agents, perhaps, as Michigan is doing.

There was an adage, once, that the good farmer could always use the advice of the county agent better than the poor one. Well, the time has come now to test it out. Poor farmers are disappearing fast—and the best, more efficient ones are remaining. These skilled farmers will need more fresh, powerful ammunition than ever, and *the county agents will bring it.*

I have always felt that there is a niche reserved in the hall of fame for folks who do ordinary tasks a little better, without vainglory or public acclaim. When such sturdy folks are called to final reckoning, there won't be so much argument about how they stood on a lot of unanswerable things, but a true prayer will rise over their ashes—that they worked long hours, diligently, with everyday folks for the achievement of all the "ordinary" things that make up our lives, our fortunes, our hopes.

The county agent circuit-rider has really been a fervent missionary. This zeal makes him No. 1 man for the agricultural revolution just ahead.

◄◄◄

EQUIPMENT AVAILABLE

FOR BAND PLACEMENT

Most of the major machinery companies make equipment that will place fertilizers safely and effectively for row crops. In most instances, this is accomplished with a separate disc opener or a shoe that adjusts sideways and up and down.

Some companies are making conversion kits which will convert a split-boot applicator to band placement. The extra cost of this kit or regular band placement equipment usually does not exceed $10 per row of planting equipment. Thus, placement is a relatively minor expense in comparison to fertilizer cost.

It will pay to check with the farm implement dealer to make sure he has or can get band placement equipment.

Care should be taken to check carefully the relative position of the fertilizer and seed when using band placement equipment. This should be done in a portion of the row where the machine has been operating at normal planting speed. A careful check should be made when first starting out in the spring and periodically thereafter. Sometimes the opener may hit an obstacle and get thrown out of position.

FERTILE FACTS

VIA BROCHURES · REPRINTS · HANDBOOKS

The following article reprints on profitable soil and crop management are available on request. Please indicate the reprint code and the number you desire. The address is: American Potash Institute, 1102 16th Street, N. W., Washington 6, D. C.

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L-5-56	Give Your Plants a Blood Test—Guide to Quick Tissue Tests
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A-1-56	Why More Alfalfa?
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FIELD CROPS

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C-1-56	A Successful Corn Crop on the Same Land Every Year Is a Possibility
M-5-56	The Placement of Fertilizer for Peanuts
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M-5-57	Building Tomato Yields Through Deep-rooted Legumes and Fertilizer Treatment

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P-3-55	N-P-K for Deciduous Fruit Trees
X-5-55	What Is Happening to Our Citrus Soils?
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SOILS AND FERTILIZER—GENERAL

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G-2-56	Plant-Food Content of Crops—Guide to Rotation Fertilization
H-3-56	The Application of Fertilizers in Irrigation Waters
V-11-56	Potassium—The Alkali of Life
C-2-57	Potash Fertilizers & Their Behavior
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GENERAL

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G-3-57	A System for Recording Soil Fertility Data
N-5-57	Growing Azaleas and Camellias—Glory of Spring
S-8-57	Potash and Soap Ashes—Early Jamestown Commodities
T-8-57	Pedagogues of the Plow

Looking at . . .

Fertilizer Consumption Trends

Veteran consultant says . . .

1. Increased usage of fertilizers, in the future, will depend largely on education and population growth.

2. Use of fertilizers in growing turf, lawns, flowers, and suburban vegetable gardens will increase more rapidly in the future than that on farms.

3. Analysis of the average mixed fertilizer will continue to increase for many years . . . true for 20 years, with factors favoring higher analysis now greater than ever before.

4. Probably by 1959-60 the average content of all fertilizer consumed (mixtures and materials) will total about 32% N, P_2O_5, and K_2O in about equal proportions of each . . . with relatively little mixed fertilizer having under 24% available nutrients.

COMPARED with any year before 1940, the present rate of fertilizer consumption is on a very high plateau and recent changes have been relatively small.

They do, however, definitely show a reversal of the trend exhibited for so many years. After examining in some detail the trends shown by fertilizer and plant food consumption in the recent past, we will give an opinion of what this means for the future.

The all-time U. S. high record for fertilizer consumption of 23,421,608 tons was set in the year ended June 30, 1953. Starting in 1940, new high records were set every year until 1953, except for 1949-50, when consumption decreased 1 percent from that of the previous fiscal year. Since 1953, tonnages of fertilizers used have declined each year. Consumption in 1955-56

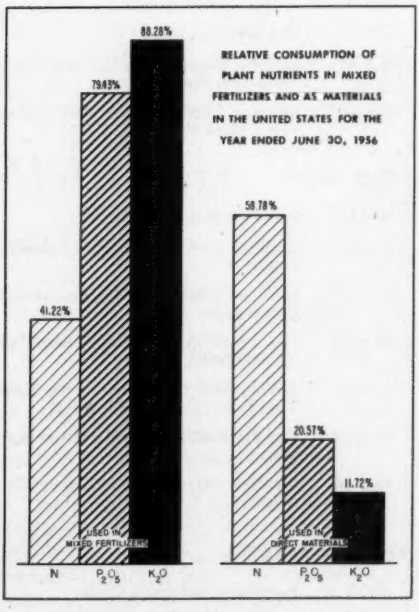


Fig. 1. This USDA report, for the year ended June 30, 1956, shows the relative use of plant nutrients in mixed fertilizers and as materials for direct application—indicating 88% of the potash consumed is in mixed fertilizers.

was 22,193,070 tons, or 5.2 percent less than in 1952-53.

Though the tonnage of fertilizers started dropping in 1953, *the quantities of plant food used continued to rise until 1955-56.* Then, for the first time since 1938, the tonnage of plant food consumed was less than in the previous year. This apparent difference in trend during 1954 and 1955 was due to the average nutrient content of fertilizers rising steadily since 1918. And for two years this rise in concentration was enough to offset the decrease in tonnage of fertilizers.

All Fertilizers

Many statements in the literature leave the impression authors assume all fertilizers to be used in agriculture. At the end of World War II, about a half million tons of fertilizers were used annually for growing turf and for other non-farm purposes. By 1954 this usage had *increased to about two million tons.* Thus, non-farm use increased *four-fold, while agricultural use doubled.* The extent to which these two general uses fluctuated in the meantime is not known. A rapid rise in non-farm use toward the end of the period may have masked a drop in farm use before it became apparent in a drop in total consumption.

The growth in usage since 1938 has not been uniformly distributed over the entire country. The curves in Fig. 2 show how it has varied in different regions. They were plotted from index numbers based on the 5-year 1935-39 average for each region computed as 100.

The curves for the Middle Atlantic and South Atlantic Regions are so

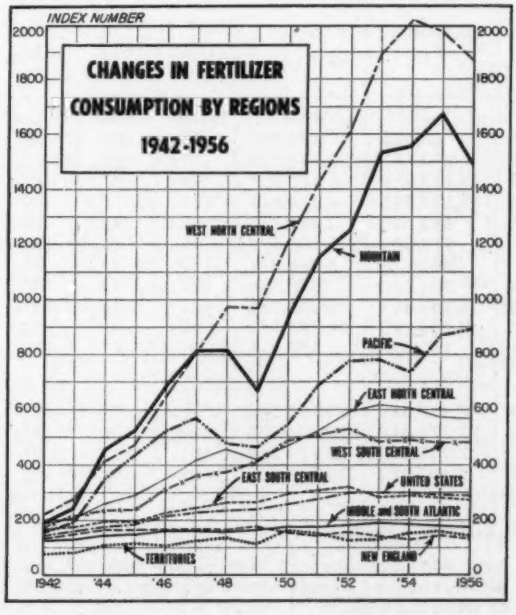


Fig. 2. Index numbers of fertilizer consumption by regions based on the 5-year, 1935-39, average for that region as 100. Source: 1940-1953, inclusive, p. 118, USDA Statistical Bul. 191. Later years, computed from data in publications of Scholl and co-workers.

By

A. L. Mehring

Hyattsville

Maryland

Mr. A. L. Mehring—for over 3 decades a chemist, senior chemist, and fertilizer statistics specialist for the USDA—is a well-known authority on fertilizer trends. Now retired, he is a private consultant in the field.

nearly alike that they cannot be shown separately on this chart. During the past five years, consumption in these Regions has remained at about 80 percent above the 1935-39 level. In 1935, these two Regions together accounted for 61 percent of the total U. S. consumption, but in 1955-56 for only 36 percent.

The growth of fertilizer consumption in some regions, especially the Mountain and West North Central States, has been spectacular on a percentage basis. Averages of actual consumption, however, in the base period were only 25,361 tons for the Mountain States and 110,386 tons for the other regions. From these comparatively low levels for such large areas, the 17-fold increase in the Mountain Region has brought consumption up to a level comparable with that for the much smaller New England Region and the augmented West North Central Region consumption up to that of the Middle Atlantic Region level.

The Pacific Region's latest index number of 896 is the only one for any region in 1955-56 that is higher than for any previous year.

A summary is presented in Table I of data by regions given by Scholl et al. If the figure in column 4 is under 100 and the column 5 and 6 figures are progressively smaller, the trend has been downward for 3 straight years. This was the general trend, although it varied somewhat in different regions.

Table I.—Consumption of Fertilizers, Year Ended June 30 1956 [1]

State and Region	Mixtures	Materials [2]	Total	Compared with [3]		
				1954–55	1953–54	1952–53
	Tons	Tons	Tons	Percent	Percent	Percent
New England	347,570	68,687	416,257	95	100	88
Middle Atlantic	1,739,884	203,113	1,942,997	91	94	92
South Atlantic	4,839,495	1,113,912	5,953,407	98	97	95
East North Central	3,379,849	1,134,995	4,514,844	100	94	89
West North Central	1,181,797	882,528	2,064,325	95	93	99
East South Central	1,980,701	919,689	2,900,390	99	96	91
West South Central	703,089	665,722	1,368,811	100	98	98
Mountain	47,876	331,860	379,736	89	97	105
Pacific	308,898	1,944,487	2,253,385	102	125	111
Continental U. S.	14,529,159	7,264,993	21,794,152	98	97	95
Territories	246,494	152,424	398,918	91	97	106
Total:						
1955–56	14,775,653	7,417,417	22,193,070	98	97	95
1954–55	15,347,850	[4] 7,378,612	22,726,462	100	100	97
1953–54	15,541,076	7,232,423	22,773,499	101	100	97
1952–53	15,722,224	7,690,384	23,412,608	105	97	100

Source: Scholl, Wallace, Fox and Crammatte, ARS, Rept. 41–19.

[1] Includes ground phosphate rock, basic slag, secondary and trace nutrient materials, such as borax, sulfur, gypsum, magnesium sulfate, etc., used as separate materials, and government distributed fertilizers. Does not include liming materials.

[2] Does not include any materials used to manufacture commercial mixtures.

[3] In some cases the data given here, and especially those for the Mountain and Pacific States, differ slightly from the originals, because they included only fertilizers guaranteed to contain one of the three primary plant nutrients. The present data were computed from the totals given in the respective annual reports.

[4] Revised.

Mixtures

The quantities of commercial mixtures shipped to consumers and dealers are shown for each region in Table I. For the United States such mixtures were 66.6 percent of the total consumption, or about the same part of the total that it has been for many years.

The relative use of nitrogen, phosphorus and potassium in mixed fertilizers and in materials for direct application is shown in Fig 1. About 41% of the nitrogen, 79% of the P_2O_5, and 88% of the potash was used in mixed fertilizers.

Tonnages of 1,536 different grades were reported to Scholl for the 1955-56 season. Of these, 1,402 were sold in continental United States. During World War II, the War Production Board limited the number that could legally be sold in order to save manpower and materials and to reduce costs. In the year ended June 30, 1945 only 271 grades were sold and 24 accounted for 84.1 percent of the total.

The number of grades on the market has been growing constantly ever since, as shown in Table II. With six times as many grades being sold in 1955-56 as in 1944-45, five grades, nevertheless, accounted for *nearly one-third, ten for one-half, 25 for three-fourths,* and *171 for 96 percent of the total.*

Many of the most important grades of mixed fertilizers sold in 1955-56 were much less important, or not even sold, ten years earlier. The differences in the percentages after each of the 37 most popular grades in the past season in Table II show changes in their importance that have occurred during the past ten years.

For the first time in 1955-56, the 5-10-10 grade became the most important, as measured by the amount sold. For the previous six years, 3-12-12 had been first, and for part of that time 5-10-10 was second, and 5-10-5 third. The 2-12-6 grade held first place before the 3-12-12 grade. The 3-9-6 was second for several years. The 2-12-6 now stands 49th, and 3-9-6 is 13th in the order of tonnages sold.

Although the 5-10-10 grade accounted for more tonnage in 1955-56 than 3-12-12, the total of all grades with a 1:4:4 ratio represented 17.42 percent of the total tonnage of mixed goods, and those with a 1:2:2 ratio 13.88 percent. The comparative parts of the total accounted for by grades with 1:1:1 and 1:3:3 ratios are 10.86 and 1.47 percent. Thus tonnages of grades with these 4 ratios of nutrients alone add up to *more than half the total for 1,402 different grades.*

The grades recommended by agricultural authorities today are usually those with simple ratios of plant nutrients, such 0:1:1, 1:1:1, 1:2:1, 1:4:4, etc. *The first nine grades in Table II all have simple ratios of the three principal nutrients.*

This is also true of most of the others that have increased rapidly in tonnage in recent years. On the contrary, most grades that do not have simple plant food ratios, such as 4:10:7, 4:10:6, 4:8:6, 4:7:5, and 6:8:4 are decreasing in importance, or barely maintaining their position.

In a number of instances, two or more grades are available with the same plant food ratio, for example, 4-8-8, 5-10-10 and 8-16-16. In general, those containing 25% or more nitrogen, available P_2O_5 and K_2O are increasing in tonnage, and those with less are decreasing, or barely holding their own.

The increase in concentration is being forced by the high cost of labor and freight.

On a regional basis, the market is dominated by a smaller number of grades than on a national scale. In 34 states, three grades account for more than one-half of the total tonnages of all mixed fertilizers. In Alabama, Georgia, Mississippi, Montana, New Jersey, and Tennessee, a

Table II.—Consumption of Mixed Fertilizers in Continental United States by Principal Grades, Year Ended June 30, 1956, and Proportion of Total, Years Ended June 30, 1946, 1951, 1955 and 1956

Grade	Consumption 1956	Part of Total			
		1956	1955	1951	1946
	Tons	Percent	Percent	Percent	Percent
5–10–10	1,296,912	8.93	9.16	4.29	2.81
3–12–12	1,171,479	8.07	9.38	13.50	3.93
4–12–12	737,215	5.07	3.33	.24	....
5–20–20	699,511	4.81	3.75	.21	....
5–10– 5	678,083	4.67	5.07	6.58	6.18
10–10–10	659,090	4.54	4.81	.53	.03
4–16–16	615,596	4.24	4.66	.89	.04
12–12–12	500,839	3.44	2.04	.11	....
3– 9– 9	478,163	3.29	3.28	2.56	1.73
4–10– 7	469,543	3.23	4.25	3.41	2.47
2–12–12	400,811	2.76	2.91	2.35	.41
4–10– 6	368,797	2.54	2.82	4.53	5.57
3– 9– 6	367,517	2.53	3.28	6.28	8.18
6–12–12	334,595	2.30	1.86	.59	.01
0–20–20	310,275	2.14	2.27	1.59	.33
6– 8– 8	268,288	1.85	1.76	1.60	.62
4– 8– 8	219,923	1.51	1.87	1.94	2.95
8– 8– 8	207,987	1.43	1.50	1.08	.33
4– 8– 6	190,357	1.31	1.65	4.29	5.28
0–14–14	174,442	1.21	.86	1.72	.08
3–12– 6	152,357	1.04	1.40	5.34	8.13
4–12– 8	146,648	1.01	.99	1.78	1.90
8–16–16	140,341	.97	.83	.28	.20
5–10–15	128,086	.88	.74	....	....
6– 8– 6	123,735	.85	1.06	1.93	1.94
10–20–10	121,165	.83	.58	.09	....
4– 7– 5	115,248	.79	.78	.87	1.42
4– 8–10	115,008	.79	.64	.04	....
6– 8– 4	104,043	.72	.82	1.91	2.78
3– 9–27	95,000	.66	.73	.17	....
6– 6– 6	85,327	.59	.51	.26	.27
6–24–12	84,454	.58	.43	....	....
4–12– 4	84,300	.58	.69	2.67	5.06
6–10– 4	77,937	.54	.48	.40	.36
8–24– 8	72,908	.51	.57	.28	....
2–12– 6[1]	27,156	.18	.29	4.31	13.58
0–12–12	20,064	.13	.19	1.06	2.31
37 listed grades		81.42	81.24	79.68	78.90
Total Tons		14,529,159	15,068,187	13,640,938	9,963,042
Total number of grades reported		1,402	1,342	997	306

[1] 13 grades in order of tonnage shipped in 1956 between the 8–24–8 and 2–12–6 are left out of this table because they have not been important during the period shown. Several former best sellers, such as 2–8–2, 3–8–3, 3–9–3, 3–8–5 and 4–8–4 are no longer of any significance.

single grade actually accounted for *more than one-half of total sales of all grades.*

The importance of a few grades in many local areas is due to the recommendations of agronomists, county agents, agricultural teachers, and soil testing laboratories. What has been found best for growing a given crop under local conditions of soil, climate, and economics by the State Experiment Station is widely recommended and rightly so. With new discoveries and changing economic conditions, recommendations gradually change and usage changes, too.

The number of persons getting advice from state soil-testing laboratories in 1956 alone runs into the hundreds of thousands. A result of the rapid development of soil quick-tests. Under present conditions, selling a grade not recommended by either state or national authorities is a tough job, in spite of the tendency of customers to continue buying the grades to which they have become accustomed.

Usage of mixed fertilizers increased greatly from 1945-46 to 1955-56, although there was a slight drop in the last year, except the P-K mixtures. The tonnage of this kind (P-K mixtures) continued to increase. P-K mixtures are used principally on hay and pasture. This indicates that education encouraging fertilization of grass crops is getting results.

Materials

Consumption of fertilizer materials for direct application, or home mixing, amounted to 7,417,417 tons in 1955-56, or *about one-third of the total.* This tonnage for separate application is 0.53 percent more than was shipped in the year before, and 56 percent more than 10 years earlier. Much of this increase is accounted for by chemical nitrogenous materials, with two and one-half times as much now being used as 10 years ago.

Fig. 1 shows about 59 percent of the nitrogen, 21 percent of the P_2O_5, and 12 percent of the potash in all fertilizers was used in materials for direct application.

The annual consumption of anhydrous ammonia, aqua ammonia, and urea is growing, but that of most of the other nitrogenous chemicals is decreasing. Thirty-nine percent of all the nitrogen used as a separate application in 1955-56 was in a liquid form. The use of commercial dried manures and sewage sludge has increased greatly in the past ten years. Most of the tonnage of these materials has been used on turf and flowers.

Ammonium phosphates have been increasing in importance for many years. Consumption of normal superphosphate in 1955-56 was less than one-third of the 1945-46 usage as a separate material, and in 1955-56 dropped in every region of the United States. More than three times as much concentrated superphosphate is now used as ten years ago. At one time the entire production of bone meal and animal tankage was used as fertilizers on farms, but since World War II most of it has been used in manufacturing feeds. The bone meal still used as fertilizer is now almost exclusively used by home gardeners.

The use of potash as a separate fertilizer has always been relatively small. In 1955-56, only 404,839 tons, or 6 percent, of all fertilizer materials that contained guaranteed amounts of N or P_2O_5 or K_2O consisted of potash materials.

More 50 percent potassium chloride was bought by farmers than 60 percent grade in every year before 1952, although 60 percent material had been available since 1923. Until after World War II, the switch on the part of farmers from 50 percent muriate to 60 percent potassium chloride had been very slow. High freight rates in recent years have speeded it up. The data indicate that 50 percent muriate may practically disappear from the market in the near future.

Nutrients

The tonnages of N, available P_2O_5, and K_2O consumed in 1955-56 by regions are given in Table III.

The average total plant-food content of mixed fertilizers and of all fertilizers consumed in nearly all states had been roughly 14 percent in every year until 1919 since commercial fertilizers were first manufactured. A close correlation has always existed between the plant food content of mixed fertilizers and of all fertilizers. For a long time after 1919 the increase in plant-food content was slow, but in the last few years it has been rapid.

As recently as 1947-48, the average was under 20 percent for many states and over 25 for only ten. In 1955-56, the average for most of them exceeded 25 percent and for eight states exceeded 40 percent.

The amount of potash used was practically the same in 1955-56 as in the preceding year, but the respective quantities of nitrogen and available P_2O_5 were 1.4 and 1.6 percent lower.

U. S. plant-food consumption nearly doubled from 791,000 tons in 1921 to 1,526,000 tons in 1930. It dropped during the depression to 819,000 tons and then gradually recovered to about the pre-depression level in 1937 and 1938. From the beginning of World War II to 1954, plant-food consumption increased 277 percent, or an average of 18.5 percent annually. In the 5 fiscal years ended June 30, 1950 to 1955, the increases were 16.5, 10.1, 8.5, 4.4, and 3.8 for each succeeding year. But in 1955-56, for the first time since 1938, consumption was lower than in the previous year, with a drop of 1.05 percent.

Conclusions

The tremendous boosts to fertilizer usage caused by the dislocations of World War II and the Korean War have run their course. From now on, barring another war, growth in the use of fertilizers will be at a more modest rate.

Table III.—Consumption of Primary Plant Nutrients and Their Content in All Fertilizers, 1955-56

State and Region	Nitrogen	Available P_2O_5	Potash	Primary Nutrient Content
	Tons	Tons	Tons	Percent
New England	27,186	47,290	43,434	28.35
Middle Atlantic	113,039	222,204	188,873	27.03
South Atlantic	385,783	469,883	490,446	22.98
East North Central	268,209	565,295	592,673	31.60
West North Central	241,007	332,508	166,961	35.91
East South Central	277,419	262,226	226,442	26.43
West South Central	211,814	164,083	90,375	34.13
Mountain	73,407	60,071	3,104	37.98
Pacific	277,507	104,332	33,330	26.01
Continental U. S.	1,875,371	2,227,892	1,835,638	28.27
Territories	57,232	19,528	39,080	29.25
Total: 1955–56	1,932,603	2,247,420	1,874,718	28.29
1954–55	1,960,536	2,283,660	1,874,943	27.90
1953–54	1,847,416	2,234,548	1,813,594	26.61
1943–44	617,000	1,296,600	641,800	20.28
1933–34	270,000	515,000	258,900	18.30

Source: Scholl, Wallace, Fox and Crammatte, Loc. Cit.

Variations in consumption must be expected because of the vagaries of weather and markets for agricultural products. Increased usage of fertilizers will depend primarily on education and population growth.

The use of fertilizers in growing turf, lawns, flowers, and suburban vegetable gardens will increase more rapidly in the future than that on farms.

The concentration of the average mixed fertilizer will continue to increase for many years. We may be certain of this, because almost every condition affecting the manufacture and use of fertilizers pulls in that direction. This has been true for 20 years, but the differences in favor of the higher analysis mixtures are now much greater than ever before. Nothing that can change this trend is evident at present.

It therefore appears probable that by 1959-60 the average content of all fertilizer consumed (mixtures and materials) will total *about 32 percent of N, P_2O_5, and K_2O in about equal proportions of each.* Relatively little mixed fertilizer will then be sold that contains *less than 24 percent of available nutrients.* ◄◄◄

MAKING LOW-FERTILITY SOILS PRODUCE HIGH ALFALFA YIELDS

Fertilizer and lime can make low-fertility soil produce high yields of alfalfa hay year after year, according to two University of Wisconsin soils specialists.

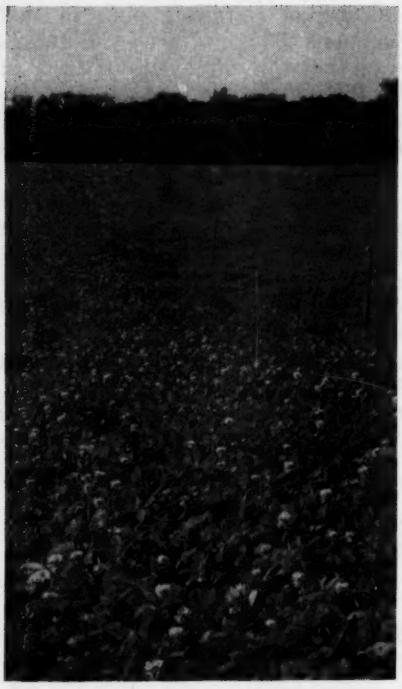
O. J. Attoe and A. E. Peterson report that alfalfa hay yields have averaged 3½ tons per acre annually for the past eight years on this low-fertility land that was built up with a full feed of plant nutrients following adequate liming. Attoe is head of the University's department of soils and Peterson is an assistant professor.

Before the soil improvement program was launched in 1947, the soil in the test field was the most acid and least fertile in the area. Many farmers had to buy hay at $30 or $35 a ton to feed their dairy cows.

Back in those days farm advisors figured alfalfa couldn't be grown in this area, Attoe and Peterson report. Now these advisors are telling farmers they can keep a good field of alfalfa productive as long as they want to with proper fertilization.

The Wisconsin soils men report that the most satisfactory first treatment on the test field was about 5 tons of ground limestone and 500 pounds per acre of 0-10-30 fertilizer.

Starting in the fall of the second-year hay, the field was topdressed with 200 pounds of potash. Alfalfa that didn't get the topdressing soon became stunted and later died from winter injury, Attoe and Peterson say.



Longevity of ladino demands following some system of management which permits a recovery growth of 8-10 inches between grazings.

Key To Long-Life LADINO

MORE ladino clover is grown on Vermont farms than any other single forage crop.

A Bench Mark Survey conducted throughout the state in 1952-1954, covering 1,099 Vermont dairy farms, revealed that ladino was grown on 54% of the farms, bromegrass on 41%, and alfalfa on 36%.

In spite of its popularity and the accumulation of facts on its culture, farmers still find it hard to maintain uniform ladino stands from year to year. Many lose their stands after just one year, others after two or three years. Several characteristics of ladino clover are not shared by other legumes.

Dr. Glen M. Wood, born in Texas and raised in Rhode Island, is Associate Professor of Agronomy at the University of Vermont. He earned his B.S. from Rhode Island University, his M.S. and Ph.D. from Rutgers. His specialty is research and teaching in the field of forage and pasture crops. He has authored and co-authored several articles in the field for professional journals.

- *Over one-third of Vermont's ladino growers who successfully establish the crop are unable to keep it for more than two years.*

- *Many ladino growers in Vermont lose their stands in just one year and only 18% maintain stands for more than five years.*

This five-year-old clover stand in Charlotte, Vermont, was developed, without seeding, from an old grass meadow. Management included frequent applications of potash carrying fertilizers during the grazing season. In 1957, the stand received 250 pounds of 8-16-16, 250 pounds of 8-12-12, and 300 pounds of 0-15-30 per acre.

Except for its smaller sister, common white clover, ladino is the only legume grown in New England that spreads by creeping stems or stolons in the manner of strawberries.

The death of the original taprooted mother plant occurs largely during the second harvest year. Growth from then on is entirely from stolons which may spread laterally as much as three or more feet in a season.

Even when used exclusively for pasture, ladino will mature seed on short or horizontally held peduncles, providing additional insurance for continuance of the stand.

• *Experiments and farmers' experiences show most soils need 180 pounds of potash per acre annually to maintain long-lived clover stands.*

• *To help maintain long-lived stands, provide rest periods between grazings, prevent under and over grazing, apply manure against winterkilling.*

By Glen M. Wood

Department of Agronomy

University of Vermont

Although climate and other factors influence results, the way a farmer *manages his ladino after establishment* largely determines its success or failure. Excellent ladino stands can be maintained, with vigor equal or superior to that following establishment, at least into the fifteenth year. A farmer can also rejuvenate a poor stand of ladino into an excellent stand by sound management.

Because of ladino's shallow root system, an adequate moisture supply is more critical to its persistence than with other more deeply rooted legumes, such as alfalfa or bird's-foot trefoil. Therefore, ladino should be seeded *only on high organic matter loams* or *silt loams with a good water-holding capacity*. If they have an even supply of moisture throughout the season, lighter soils, such as river bottomland, are also satisfactory.

Ladino Survey Conducted

In 1953, a state-wide ladino survey was made to learn why some Vermont farmers can maintain ladino indefinitely while others lose their stands in one to three years.

A questionnaire was sent to all county agents for distribution to farmers in their county. Over 100 completed questionnaires were returned—an average of seven farms in each of Vermont's 14 counties. Though the number of farms was small, those who cooperated were considered by the county agents to be better farmers. Thus the data obtained may indicate somewhat higher ladino survival than would have been found in a more inclusive sampling.

Questioned on the persistence of ladino, 37% of the farmers said they lost their clover in three years or less; 45% kept stands three to five years; only 18% maintained stands over five years. The average stand life for each of these groups was two, four, and six years, respectively.

Best Used for Pasture

Ladino is best used as a pasture crop. Being a creeping plant, it rarely grows over 1 to 1½ feet high, while associated grasses frequently grow 3 feet or more. Ladino cannot take low light intensities, and prolonged shading by erect type grasses soon kills it. Pure stands of ladino are not easy to hay or ensile because of the creeping tangled growth. Also, its high moisture content makes curing as hay very difficult.

Frequently the first crop of a ladino-grass pasture must be cut for silage or hay in order to make best use of spring surpluses. Cut the crop early, in this case. None of the Vermont farmers surveyed who kept their ladino six years or more reported cutting their first crop late (Table I). If the crop is cut *when the grasses are in head, but not in bloom*, a high quality forage will be harvested with little or no injury to the ladino.

Controlled Grazing Pays

Unlike so-called native pasture of

Table I.—Persistence of Ladino Clover as Related to Time of Cutting First Crop If Used for Hay or Silage*

Avg. stand life	Farms reporting	Time of cutting†		
		Early	Avg.	Late
Years	No.	Percent of farms		
2	22	73	18	9
4	37	78	19	3
6	34	85	15	0

* Based on 1953 state-wide ladino clover survey.
† Geographical location taken into account in determining earliness.

Table II.—Persistence of Ladino Clover as Related to Height of Grazing*

Avg. stand life	Farms reporting	Estimated height of grazing		
		Heavily (1″–2″)	Moderately (2″–3″)	Lightly (3″–4″)
Years	No.	Percent of farms		
2	16	38	62	0
4	36	25	64	11
6	34	23	65	12

* Based on 1953 state-wide clover survey.

Kentucky bluegrass and wild white clover, ladino and the taller-growing grasses cannot be grazed continuously. This is very true of ladino because its leaves are held considerably above the "bite-line" by tall petioles, making it easy for cows to strip the plant. Continued removal of these clover leaves destroys the food-manufacturing areas and the plant literally starves to death.

The problem is to keep adequate reserve levels in the stolons and roots of ladino. This requires some system of management permitting a recovery growth of 8 to 10 inches between grazings.

Many ladino pastures in the northeast are worked out by continued or too close grazing during hot, dry weather. Overgrazing removes the protective canopy of leaves, exposing both soil and creeping stems to the broiling sun.

This type of summer killing occurs even in the relatively northern state of Vermont. The June 19 temperature of bare soil was recorded at Burlington in 1953 at 124° F., whereas an adjacent area under just 3 inches of forage was only 86° F., a difference of 38° F. Since many cool season crops cease growing at 90° F. to 110° F. and die at 110° F. to 130° F., we can see why ladino stands can be lost if closely grazed during hot, dry weather.

Farmers with the longest-lived stands in the Vermont ladino survey generally grazed more lightly than those reporting shorter-lived stands (Table II). Grazing to a height of 2 to 3 inches is best for ladino in association with such tall-growing grasses as brome or orchardgrass.

Ladino-grass stands should not be grazed too lightly, however. Grasses store much of their reserve food in the lower or basal portion of the leaves and stems. Unless periodically grazed off at 2 to 3 inches high, the grass reserves grow so fast they compete excessively with the less aggressive ladino.

Unlike alfalfa, fall grazing of ladino during September and October will not normally hurt the stand. The clover should be allowed, however, to go into the winter with a 3 to 4-inch stubble, to provide some insulation and help trap snow.

Ladino Yields Well Alone or With Grasses

University of Vermont experimental plots seeded to ladino alone and with three grasses yielded well when topdressed annually with an average of 600 pounds per acre of 0-15-30 in two applications. Table III shows the dry weight yields of trial plots for four years. In these trials, bromegrass-ladino was the highest yielding combination.

Potassium, Key to Persistence

Research at the Vermont Experiment Station clearly shows that *ladino will not persist unless given enough potassium.* From 1952 through 1955, different rates of potash were applied annually to simulated pasture plots.

Although climate and other factors influence results, the way a farmer *manages his ladino after establishment* largely determines its success or failure. Excellent ladino stands can be maintained, with vigor equal or superior to that following establishment, at least into the fifteenth year. A farmer can also rejuvenate a poor stand of ladino into an excellent stand by sound management.

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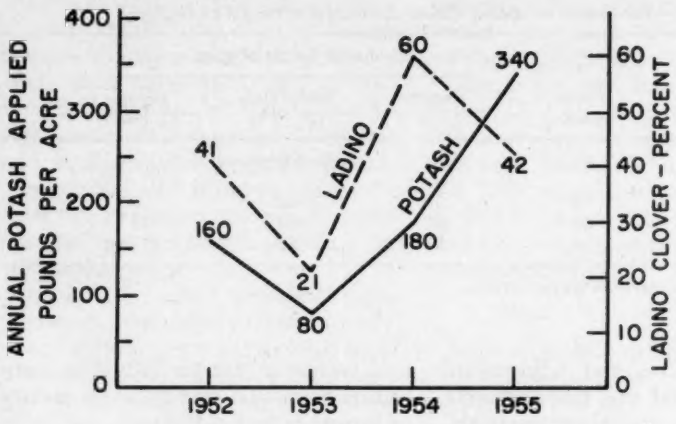


Fig. 1. Effect of potash on percent of ladino clover in experimental pasture plots (dry weight basis).

At the time of the last cut, samples were taken from the plots and the percentage of clover determined by hand separation.

Fig. 1 shows the relation of potash applications to the percentage of clover present for the period 1952-1955. The 80-pound rate in 1953 produced the lowest percentage of ladino clover, while the 180-pound rate in 1954 produced the highest percentage. In 1956, no fertilizers were applied to the experimental area and, although the plots were cut, neither yield nor botanical composition data were determined. In May, 1957 the plots were again harvested and the average clover percentage had dropped to a low of 16.5%.

It would appear from this that very little, if any, residual potash from the 1955 application of 340 pounds per acre had remained to the benefit of the clover. Undoubtedly the interaction of climate and other factors played a part in these results, *but the obvious relation between clover growth and potash application is still quite evident.*

Perhaps it is more than coincidental that the state-wide ladino survey showed *180 pounds* to be the amount of potash applied by the farmers *who successfully maintained their stands for an average of six years* (Table IV). This rate falls within the range recommended by other northeastern states. At least two states other than Vermont recommend this exact amount for maintaining a high-yielding ladino pasture.

The rate of potash application

Table III.—University of Vermont Plot Yields of Ladino Clover Grown Alone and with Grasses Under Experimental Pasture Conditions

Ladino association	Yields of dry forage in tons per acre				
	1952	1953	1954	1955	Average
Alone	2.5	2.1	2.9	3.2	2.7
Late orchard grass	2.6	2.1	2.0	2.7	2.3
Commercial orchard grass	2.9	2.3	2.5	2.8	2.6
Bromegrass	2.6	2.3	3.2	3.3	2.8
Average	2.7	2.2	2.6	3.0	

Table IV.—Persistence of Ladino Clover as Related to Average Phosphoric Acid and Potash Applied*

Avg. stand life	Farms reporting	Phosphoric acid used	Potash used
Years	No.	Pounds per acre	
2	18	98	123
4	38	117	132
6	36	142	180

* Based on 1953 state-wide ladino clover survey.

should be adjusted to soil type. For example experiments on a Paxton soil in New Hampshire showed 60 pounds of potash per acre would insure clover persistence. In general, much greater amounts of potash are needed merely to replace what is removed by the crop.

As stated by Brown: "Regardless of frequency and size of application, an ordinary yield of three tons per acre of ladino-grass dry matter, containing only a medium concentration of 2% potash, removes 120 pounds from the soil each year. Maximum yields have not been obtained at this station with less than 180 pounds per acre of K_2O every season."

Generally speaking, lighter soils may require more than 180 pounds of potash per acre. Heavier soils can support good clover stands with less.

Why Potassium Is So Important

For a number of reasons potassium, supplied largely by commercial fertilizers, is very important to ladino stands.

In the first place, it is needed for such basic functions as food manufacture, resistance to disease, and efficient use of water.

Ladino clover contains a higher percentage of potassium than any other mineral element.

Since potash is water soluble and tends to be leached down below the feeding zone of shallow-rooted ladino clover, pastures containing this legume should receive smaller and *more frequent applications for best results.*

Seventy-one percent of the Vermont farmers reporting good ladino stands for an average of six years put on two or more applications of fertilizer annually. Only about half (53%) of the farmers reporting shorter-lived stands (three years' average) put on two or more applications.

Grasses and many weeds can extract potassium *much more readily from the soil* than can a leguminous plant such as ladino. If the supply of potassium is limited, the clover is the first to suffer and be eliminated from the sward.

Phosphorus, though less critically, is also important to the persistence of ladino (Table IV). Vermont farmers whose stands lasted an average of six years topdressed with 142 pounds per acre of phosphoric acid. Total fertilizer was applied in the form of 8.1 tons per acre of phosphated manure, plus the equivalent of 400 pounds per acre of 0-15-30.

Boron Requirements

In 1947, Midgley and Dunklee made chemical studies of 39 different Vermont soil types. Approximately half were lacking in boron and most of the remaining soils needed extra boron for crops such as alfalfa and ladino.

To guard against boron deficiency, a mixed fertilizer containing boron should be used when seeding down, or used occasionally as a topdressing on established stands. Do not apply too much, however, since continued topdressing of borax, even at 10

pounds per acre each year, may have detrimental effects on yields of grass-ladino mixtures. Ladino's shallow feeding characteristic makes it sensitive to the continued surface application of boron. This is less apt to be a problem with deeper-rooted plants such as alfalfa and red clover.

No other minor element deficiencies have been reported in Vermont. It is conceivable, with the increased use of high-analysis fertilizers containing little or none of these elements, that continued cropping will cause such deficiencies as in other northeastern states. When manure is returned to the land, this danger is lessened because of the minor elements it contains.

Manure Cuts Down Winterkilling

Of the Vermont farmers with ladino stands averaging six years in life, 94% applied manure to their clover. This was a considerably greater percentage than in the shorter survival groups (Table V). Farmers with the longer-lived stands also tended to apply manure during the winter and spring, rather than in fall as more commonly done.

When ladino winterkills, the damage is usually done during late winter or early spring. At this time reserve levels in the plant are low (especially under conditions of poor mineral nutrition) and drying winds or sharp temperature fluctuations can reduce a mixed clover-grass stand to mostly grass—often with one stroke.

If a natural snow cover or thick grass stubble is not present, some injury is sure to occur. Topdressing lightly with six to eight tons of manure in winter or very early spring will reduce this type of winterkilling by insulating the exposed stolons. Too much manure should not be applied because nitrogen in it may overstimulate spring growth of the grasses at the expense of the clover.

From both chemical and physical standpoints, the value of manure in maintaining ladino stands is exceptionally high. In addition to the known benefits from its major and minor elements, the role of hormones and other substances in promoting long-lived stands remains to be more fully investigated.

Pest Control

Diseases of ladino clover rarely wipe out an entire field because of the continuous creeping type growth of the plant. New plants are constantly being formed and separated from the mother plant by trampling of cattle, injury by farm equipment, frost heaving, etc. Undoubtedly yield is somewhat reduced by such diseases as sclerotinia, leaf spots, and viruses, particularly when a hay or silage cut is made during the season. Whether a program of spraying or dusting for disease control is practical remains to be worked out.

A pesticide which is effective, economical to apply, and does not leave a

Table V.—Persistence of Ladino Clover as Related to Amount and Season of Manure Application*

Avg. stand life	Farms report-ing	Farms applying manure	Avg. amt. per acre	Season applied		
				Fall	Winter	Spring
Years	No.	%	Tons	Percent of farms		
2	22	59	7.3	73	12	15
4	38	58	8.8	55	16	29
6	34	94	8.1	54	20	26

* Based on 1953 state-wide ladino clover survey.

toxic residue on the forage is of prime importance in any such program. At present, such pesticides, if available at all, are not in wide use for pastured areas.

The mowing machine is the best weed control implement the dairy farmer has. Regular clipping of ladino-grass pastures *after each grazing* not only helps to control such persistent weeds as Canada and bull thistles, but keeps the pasture uniform and insures recovery growth of young succulent herbage.

Chemicals are not recommended to control weeds in ladino-grass pastures because most chemicals that will control weeds will also injure the clover.

A well-managed ladino-grass pasture kept thrifty by timely clipping and additions of lime and fertilizers according to crop needs will not become excessively weedy.

Summary

A survey of Vermont's ladino growers revealed over a third of the farmers who successfully establish ladino *are unable to keep it for more than three years.*

Many lose their stands in just one year and only 18% maintain stands for more than five years.

Experimental results and farmers' experiences show that most soils need an annual application of *180 pounds per acre of potash* to maintain satisfactory clover stands year after year.

And some other good management practices causing long-lived stands are:

- rest periods between grazings
- prevention of both under and over grazing
- and the timely application of manure.

(Adapted from Vt. Expt. Sta. Bul 596, Managing Ladino Clover in Vermont, 1956)

◄◄◄

A KEY
TO THE UPWARD PUSH

Iowa State College agronomists report that corn yields were boosted as much as 30 bushels per acre when balanced amounts of phosphate and potash fertilizer were added to a soil that was already high in nitrogen.

These specialists say that no yield increase was noted when nitrogen was added, because the soil already had sufficient supplies of this nutrient. And only 4 bushel increase came from adding phosphate alone.

The upward push in yields came from balanced fertilization.

The soils men point out that balance in fertilization means adding fertilizer nutrients in the proportion needed by the soil for high yields.

A soil test, they say, can help the farmer find out what nutrients his soil lacks.

The Iowa agronomists emphasize that a balanced fertility program has to be accompanied by an adequate stalk population if you want to get high corn yields.

In many cases, they say, farmers do not increase their corn stands when they begin using fertilizer. This can result in less efficient use of the nutrients applied to the soil.

With small grains, on the other hand, a balanced fertility program may make it possible to cut down on the seeding rate, because of greater stooling.

New crop varieties . . .

Developing new crop varieties—from rust-resistant wheat to hybrid corn—has been one of agronomy's great contributions to the nation. Last year, varieties not in existence just 20 years ago were grown on *70 per cent* of the nation's cropland—varieties that yield more returns per acre, that resist certain diseases and insects, that insure adequate food for a rapidly growing nation.

Soil testing . . .

When agronomists developed the soil test, they opened a new era for the farmer—and for everyone with a green thumb. Today, the man who has his soil tested, or leaves from his orchard trees analyzed, can grow his crop with confidence. For when he follows those tests, he knows he is giving his crop, his orchard, his garden, or his lawn the nutrients it needs.

On December 30, the American Society of Agronomy will be 50 years old—and the vast majority of America's 160 million well-fed, Sputnik-conscious citizens will never know the difference.

To the 5,000 scientists of America who call themselves agronomists, this supposition may seem absurd. But ask the average taxpayer what agronomy is or what the agronomist does—and draw your own conclusions.

As a reporter trying to find some of the answers to these questions, BETTER CROPS looked in on the Golden Jubilee of the American Society of Agronomy and came away amazed at what this field of science has done to improve the lot of man on earth.

We learned that agronomists are experts in two areas—in soils on which our crops are grown, in plants from which our food and fiber are borne. Some of them specialize in the origin and classification of soils—called pedalogists. Others map the soils of an area—called soil surveyors. Some analyze soils in the laboratory—known as soil chemists. Others study the soil flora—called microbiologists. Some work on soil conservation problems—called conservationists. And others work on soil amendments and fertilizers

50 years of milestones

In The Age

that will increase crop yields—[illegible] *they are all agronomists.*

There are some 5,000 of them [illegible] ing, in extension, in conservati[illegible] related to the soils and plants [illegible] majority of them are in public [illegible] government agencies, the state [illegible] ment stations, and county exten[illegible]

Some work as specialists wi[illegible] liming materials, fungicides, [illegible] essential to high acre yields [illegible]

Chemical fertilizers . . .

There was a time—not too long ago—when farmers did not get the results they get today from fertilizers. Today, with agronomists showing them how, more and more farmers are using mixed plant foods of higher total analysis. In 10 years, they have more than doubled their use of chemical fertilizers—and for reasons as striking as the one above. Left, fertilizer; right, no fertilizer.

Soil conservation . . .

Agronomists specializing in soil conservation have played a major part in the attitude of the farmer toward his soil. That attitude has changed greatly since World War I, when over 80 per cent of the nation's farm land was considered either threatened by erosion or ruined. Today, soil conservation is practiced in over 3,000 soil conservation districts in all 48 states.

f Agronomy

wn as fertility specialists. *But*

w at work in research, in teach-
, and in commercial activities
the United States. The great
ice—with the USDA and other
leges of agriculture and experi-
n programs.
companies producing fertilizer,
ticides, and similar products
crops. Others work for seed-

producing agencies, some for banks, dairy companies, feed manufacturers, public utilities, and machinery producers needing such specialists to help them serve agriculture more fully.

And some farm—for themselves or for a company operating several farms for absentee owners. Others may work for an insurance company wanting to help the farmer to whom they loan money for purchasing land or improving it. And many may be employed "in any one of a great variety of related enterprises," according to their Society.

In any event—whether in public service or private enterprise—all agronomists have one mission in common: to help grow the best possible plant in the most efficient manner.

We learned that out of the many contributions agronomy has made to American agriculture, perhaps these six steps symbolize the picture: (1) New crop varieties; (2) Soil testing and plant analysis for nutrient deficiencies; (3) Chemical fertilizer technology and usage; (4) Control of insects, weeds, and diseases; (5) Soil conservation technology; (6) New improved forage grasses and legumes.

(Continued on page 26)

When a handful of agricultural scientists met in the Botany Department at the University of Chicago in 1907 to form the American Society of Agronomy, their first president, USDA cerealist M. A. Carlton, called agronomy "a science and an art which investigates anything and everything concerned with field crops."

A look at the record seems to support it. Not every deed can be mentioned, of course—nor every name—space will not permit. But some milestones stand out. For example, we learned . . .

- It takes only 12 per cent of our people now to feed the other 86 per cent.
- Since 1935, gross farm output has increased 42 per cent.
- Last year, varieties *not in existence just 20 years ago* were grown on *70 per cent of the nation's cropland.* And some of the leading varieties of major crops have changed 2 or 3 times in that period.
- In 1909, corn, oats, and wheat yielded 3.2 billion bushels from 178 million acres; in 1957, the same three crops yielded 4.3 billion bushels from 150 million acres—or a billion more bushels from 28 million fewer acres.
- From 1909 to 1954, national corn yields grew from 25 bu. to 39 bu. per acre; sorghum, 10.8 bu. to 20 bu.; all wheat, 15 bu. to 19 bu.; oats, 28 bu. to 35 bu.; barley, 22 bu. to 28.5 bu.; rice, 36 bu. to 58 bu.; tobacco, 815 lbs. to 1,230 lbs.; and sugar beets, 11 tons to 16 tons.
- In 1933, only one out of every 1,000 acres of corn was in hybrids. By 1948, its use had increased 430 per cent. And today it is planted almost universally. Three agronomists—E. M. East, G. H. Shull, and D. F. Jones—are called the "fathers of the modern universal growing of hybrid corn."
- A big step in the history of cereals was taken in 1926 when E. C. McFadden released the stem rust resistant spring wheat varieties—leading to wheat varieties nearly immune from black rust, leaf rust, bunt, and loose rust.

American Society of Agronomy . . .

From a comparative handful of members in 1907, the American Society of Agronomy has grown to 3,300 members whose varied activities exert a strong influence on the American standard of living today and on the nation's ability to sustain that standard in the future.

At one time the principal function of the Society was the exchange of current information within its membership. Today its activities cover a much wider scope. The Society fosters high standards of education in farm crops and soils—it is encouraging professional improvement among its members, supporting high standards of ethics among its members, actively promoting the use of research results in crops and soils on the nation's farms.

The Society publishes an average of 150 technical papers annually in its AGRONOMY JOURNAL, and publishes a popular magazine which attempts to shorten the span of time between discovery and actual farm acceptance of new practices. One of its sister societies, the Soil Science Society of America, publishes another technical journal, SOIL SCIENCE SOCIETY OF AMERICA PROCEEDINGS.

• Many farmers have more than tripled their corn yields by following the soil management methods recommended by modern research—such as adapted hybrids, thick spacing, cover crops, and heavy fertilization. A striking example are Southeastern farmers who increased their average corn yields 50 per cent in only 5 years by following the combined and cooperative research of their official agricultural leaders.

• Such teamwork has also brought new life to the region's pastures, through renovation and new fertilization programs.

• In developing wilt-resistant cotton varieties at the turn of the century, USDA cotton breeder W. A. Orton was not only paving the way for more successful cotton, but also the way for disease-resistant tobacco, rice, sorghum, and other southern crops.

• Soil testing was unknown or primitive, to say the least, in the early 1900's. By 1907, crude litmus paper was used to determine soil acidity. It didn't give a true test, didn't show the lime needed to correct acidity. Six years later Emil Truog of Wisconsin had devised the quick zinc sulfide-lead acetate test for acidity. And between 1920 and 1934, came phosphate and potash tests, and steady improvements of both methods, by brilliant men in the field. Today, soil testing, tissue testing, and leaf analysis have been so perfected that farmers no longer look upon them with suspicion—but use them to determine the right kinds and amounts of plant food to put on their soils for fullest returns.

• By 1923 a new era of higher analysis for commercial fertilizers began, with agronomists showing farmers how to get the best results. In the past ten years, alone, farmers have more than doubled their use of chemical fertilizers. Today farmers apply them in solid, liquid, and gaseous form. And the importance of minor plant food nutrients—such as zinc, iron, boron, and manganese—is better known.

• Plants with built-in resistance to diseases and insects are the goal of today's plant breeders. They have a good start with many of their corn, wheat, barley, oats, cotton, tobacco, sugar beets, and alfalfa varieties. Oat production entered a new era in 1946 with the Bond variety from Australia. Its derivatives, notably Clinton, replaced hel-

. . . Its Activities and Influence

The Society's membership is divided among 13 divisions and 3 subdivisions as follows: soil physics, soil chemistry, soil microbiology, soil fertility, plant nutrients, organic soils, soil classification, forest soils, soil conservation, crop breeding and genetics, crop physiology and ecology, crop production and management, seed production and technology, turfgrass management, weed control, and agronomic education.

The divisions devoted to crop science were recently organized into a second sister society, the Crop Science Society of America.

Four regional branches and several state chapters also are active, each scheduling its own annual meetings where research papers of regional significance are presented.

Agronomic research underlay America's prodigal food production in World War II which helped feed much of the Free World. The continued status of a food-surplus nation is not free of acute marketing problems, but it provides the nation with a hedge against prolonged drouth, a store-house of technology to draw on in a national emergency, and the capacity to feed scores of millions more in its population a generation ahead.

minthosporium-susceptible varieties. And today certain corn varieties resist European corn borer, corn earworm, and chinch bug; wheat varieties resist the Hessian fly; barley resists the greenbug; sugar beets resist the leaf hopper; and alfalfa resists the spotted aphid.

• Vitally important is the attitude of today's farmer toward the soil that grows these crops. His attitude is quite different from what it was before World War I, when over 80 per cent of the nation's farm land was considered either threatened by erosion or ruined. Today, *soil conservation* is practiced as a science and a practical art in more than 3,000 soil conservation districts in all 48 states.

In a recent release, the American Society of Agronomy listed chronologically a striking series of historical events they chose to call "Agronomy Milestones." A brief trip up these milestones convincingly answers who the agronomist is—and what he does:

1874—First fertilizer control law, Alabama

1879—Morrow soil fertility plots, started at University of Illinois. Oldest existing plots in U. S.

1890's—H. L. Bolley of North Dakota Agricultural Experiment Station was the first to expose plants (flax) to disease and use the surviving plants to breed true resistance. Bolley's test plot No. 30 at Fargo is marked as one of America's most famous crop salvation sites

1895—Value of legume inoculations demonstrated

1896—First experiments in chemical weed control, H. C. Bolley, Fargo, N. D.

1898—Soil classification and mapping begins

1903—First wilt-resistant seed flax distributed

1907—Research begins on soybeans breeding

1908—Egyptian cotton grown in United States

1909—Crested wheatgrass new forage crop for Great Plains

1911—Crop rotations help control nematodes
—One-variety cotton area established

1912—Ladino clover introduced in United States

1913—Depleted ranges restored by deferred grazing

1914—Fixation of atmospheric nitrogen for fertilizer
—Breed resistance to Oriental virus in sugarcane

1917—Improved terraces developed to control erosion of farm land

1918—Barberry eradication begun to control stem rust of wheat
—First permanent research program for sugarcane industry begins at Canal Point, Florida, Experiment Station.

1921—Hybrid corn a commercial success

1922—Fall planted sugarbeets overwinter successfully to produce abundant seed, cutting seed production time in half

1924—Korean lespedeza released (introduced in 1921)

1926—H. K. Hays and E. C. Stakman created and released the first smooth-awned, disease-resistant barley for the upper Mississippi valley

1929—Eubanks Carsner and D. A. Pack announced the first sugar beet variety resistant to curly top disease
—Erosion-control studies begin

1931—Improved ranges reduce soil erosion in West

1932—Golden Cross Bantam sweet corn resists bacterial wilt.
—Disease-resistant Katahdin potato released

1934—Thatcher wheat resistant to stem rust for hard red spring area

1935—Soil fumigation controls nematodes
—Reseeding legumes aid erosion control in South
—Fertilizer studies show value of side placement

1936—Nematode-resistant grape introduced
—Radioactive isotopes used in plants and soils investigations

1937—Wilting method of making grass silage developed
—Insecticides found effective against European corn borer

1938—Stubble mulch culture conserves soil and water

1939—Control methods developed to stop gully erosion
—Vegetative cover reclaims sand dunes and prevents wind erosion
—Ranger alfalfa developed by H. M. Tysdal and H. L. Westover; first to have winterhardiness and wilt resistance

1940—Combine-type sorghums become mass-production cash crop

1941—Cotton Testing Services Act provides for fiber and spinning tests

1942—Wilt-resistant tobacco developed

1943—Antibiotic streptomycin isolated from soil fungus
—DDT residual insecticide controls livestock, crop, and household pests

1944—First hybrid onion introduced
—Plant-growth regulators kill weeds

1945—Moisture-fertility-stand balance is essential to high crop yields
—Hessian-fly-resistant wheat released

1946—Organic phosphorus compounds introduced as insecticides
—Vigo wheat disease-resistant variety for soft red winter area
—Chemical weed killers used in production of cereal crops

1947—First application of anhydrous ammonia as a fertilizer by W. B. Andrews, Mississippi State College
—Hybrid corn resistant to corn borer released

1948—Chemicals cut cost of weed control in irrigation ditches by 90 percent
—New mechanized sprayers and dusters improve corn-borer control

1949—Systemic insecticides promise new approach to insect control

1953—Vernal alfalfa; hardiness and resistance plus slight yield advantage

1956—Dixiebright 244 tobacco variety released with good resistance to Granville wilt, black shank, and fusarium wilt, longtime enemies of tobacco
—Hot water treatment found successful to overcome hard seed character in cotton varieties
—Hybrid sorghum developed by J. C. Stephens and J. R. Quinby through use of cytoplasmic male sterility, reducing seed production costs, and greatly increasing yields of commercial sorghums

1957—National seed storage laboratory erected by USDA at Fort Collins, Colo., to preserve seed stocks and germ plasm of high yielding and resistant varieties
—Moapa alfalfa with resistance to spotted aphid

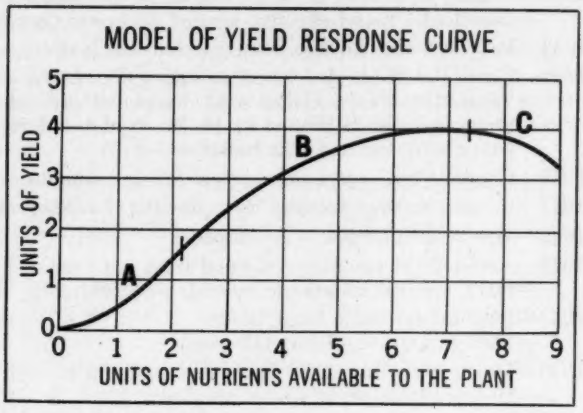
The agronomist is, indeed, a man on a mission as important as tonight's covers and tomorrow's hot meal. For without him, it is conceivable that this nation's mushrooming population would long ago have stumbled on its face from hunger and exposure.

We have tried to refrain from using any superlatives while looking at the 50-year record of this science—knowing, as we do, the attitude of some scientists toward any word that might seem to violate the hallowed practices of objective expository writing.

But we are not reporting a project—we're not delivering a paper—we're not submitting a study filled with statistics framed in tables and charts. We're saluting a half century of great service to our nation—made largely by open-collared farm boys who left their homesteads to learn more about the soil they had plowed and the crops they had tended from childhood to the first awkward, self-conscious days of enrollment in their home state's agricultural college.

We are saluting the 50th birthday of the American Society of Agronomy whose work will cease to be important when food is no longer important.

"In other words . . .



Results of a large number of fertilizer experiments show that the relation between plant nutrients and crop yield follow the general curve line. See story for details.

HOW TO USE FERTILIZERS PROFITABLY

FARMERS have many different types or kinds of expenses connected with crop production. Take rice, for example. There are cash expenses for seed, fertilizer, weed control, hauling, drying, tractor and combine operations, pumping, etc. In addition to the cash expenses, there are extra labor costs and equipment overhead costs. Economists at the Agricultural Experiment Station, University of Arkansas, have studied these costs and determined their magnitude.

At the moment, we are not interested in cost of each of the different operations or items necessary for rice production. What we are interested in is the amount of total costs involved. The Economists have determined the average production costs per acre to be $65.11.[1] It is of interest to Agronomists that of this amount $9.65 is for fertilizer and its application.

At a selling price of $2.25 per bushel for rough rice, it takes a yield of 29 bushels per acre to pay production costs. At the average yield for the entire production area in the State, which was 65 bushels in 1955, an all-time high, the calculated cost of production is approximately $1.00 per bushel. Therefore, $1.00 per bushel, in 1955, was the average unit cost of producing rice in Arkansas, at the State average yield. If the rice farmer sold his rice for $2.25 per bushel, he realized a $1.25 per bushel profit, less marketing costs.

It is extremely important to bear in mind that unit cost of production is a function of yield. Ordinarily, the greater the yield, the less the unit cost. For example, if a given rice farmer in

. . . you'd better know what you're doing"

1955 produced 100 bushels per acre instead of the State average of 65, his unit cost of production would not be a dollar a bushel, but 65 cents a bushel. Therefore, this good farmer would have realized a profit of $1.60 instead of $1.25 per bushel. Rice here is used as an example to demonstrate a basic principle which will apply to cotton, corn, small grains, pastures, etc.

There are many production factors involved in growing a crop. Fertilizer is only one factor, but an extremely important one. The use of good seed, free of noxious weeds and of high germination and adapted variety, is important. Good cultural management, proper rotation, good weed, disease, and insect control, are important. However, American farmers are depending more and more upon fertilizers for increased yields. It has been estimated by U. S. Department of Agriculture authorities that fully one third of all crop production in the United States is directly due to the use of fertilizers. In 1952, farmers in this country produced 44% more than the average for the base period of 1935-39 and did it on about the same acreage. However, they did this with 17% less labor and by use of 274% more fertilizer and 84% more power, along with other improved production practices.

Fertilizer, properly used, is one of the best investments a farmer can make at today's prices. Cost of fertilizer has not increased as much as prices of farm products or the cost of many of the things farmers use in production. Using 1935 prices for comparison, we find that fertilizer prices in 1953 were 51% greater. But the price of seed was 95% greater, machinery 110% greater, feed 114% greater, building and fencing materials 144% greater, and so on.

Both research and practical farm experience indicate that investments in fertilizer can be expected to pay a high net return on most farms. Proper use of fertilizer not only helps to increase maximum yields, but it contributes in another important way—by stabilizing crop yields and income under adverse weather conditions.

The Agronomy Department through its Soil Testing Program conducted a number of pasture experiments in Western Arkansas during 1954 and 1955. It will be recalled that 1954 was a very dry, hot year while 1955 was near normal as regards rainfall and temperature. On the unfertilized plots, the yields in 1955 were much greater than in 1954; however, on the adequately fertilized plots the yields in the dry year of 1954 were not far behind those obtained in 1955 when rainfall was adequate. Stabilization of crop yields is an important consideration in the lending of money for purchase of fertilizers.

Nor are all the benefits of fertilizer expressed in terms of higher crop yield. The increase in root and stalk growth adds more organic matter to the soil, thus improving its tilth. The increase in organic matter helps to absorb and

By D. A. Hinkle

Department of Agronomy

University of Arkansas

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hold moisture, and thus will improve subsequent crop yields.

The first essential step in profitable use of fertilizers is to have a soil test made. The soil test will show the plant-food needs of the soil and will suggest the grade or grades of mixed fertilizer and nitrogen to purchase. Furthermore, it will give an indication of proper time and method of application. It will also state whether lime is needed. Unless the soil pH is in the range of 5.5 to 6.5, the greatest efficiency possible will not be realized from the fertilizer application.

It is important to have a sound farm plan. Fertilizers cannot take the place of sound cropping practices and overall good management. Such practices as using recommended crop varieties for the area, good seedbed preparation, timely cultivation, etc. are a part of sound fertilizer use.

The question is often asked, "What is the most economical rate of fertilizer to use on a given crop under a given set of conditions?" The Economists have shown the Agronomists a very simple way to determine the most economical rate. For this purpose, the response curve to increasing increments of fertilizer is determined from experimental data.

Results of a large number of fertilizer experiments show that the relation between plant nutrients added and crop yield follows the general curve shown below.

When the soil is very low in the nutrient (or nutrients) being added, there is a segment of the curve (segment A) in which the additional yield increases with each additional increment of fertilizer. But a point is soon reached beyond which each additional unit of fertilizer contributes less to the yield than the preceding unit (segment B). Continued addition of fertilizer may result in an actual decrease in total yield (segment C).

Now let's see how the Economists determine the most profitable rate. For a given price for the crop and a given cost for the fertilizer, *this condition is obtained when a small additional unit of fertilizer multiplied by its price is just equal to the corresponding increase in yield multiplied by its price.* Thus, the relative price of the fertilizer to the price of the crop determines the most profitable rate. In years when the price received for crop is high and fertilizer costs are relatively low, the most profitable rate will be higher than when the reverse condition exists.

It cannot be overemphasized that the highest returns per dollar spent on fertilizer will fall within segment A on the curve, but the greatest returns per acre will fall within segment B at the point at which the last increment of fertilizer just pays for itself and its application.

As stated previously, the most profitable rate of use of fertilizer must fall on the curve within segment B, and it is here that the Economist has a bone to pick with the Agronomist. Agronomists in general have been rather conservative in choosing rates for their experiments. They have tried to use rates that appeared practical to them. As a result, most of the fertilizer experimental data obtained by Agronomists do not adequately characterize the response curve. In many experiments only a few rates are used and thus the curve cannot be adequately characterized because the increments were not small enough and numerous enough to accurately determine the shape of the curve. In others, rates are not high enough to reach the point of no further increase in response. In still others, the fertilizer experiment is confounded with other management or cultural practices, such as dates of planting, varieties, stand variables, etc., as to make the experiment too complex for economic evaluation.

It is my opinion that much good can come from the Agronomist and Economist working together in the field of fertilizer response. Agronomists can and should modify their experiments so the Economists can use the data for

economic evaluation. In most cases Agronomists could still get the agronomic data needed. The two professions working together will hasten the day when farmers will truly use adequate amounts of fertilizer in their farming operations.

Lack of capital is usually one of the limiting factors in adequate use of fertilizer. For the farmer with limited capital, the economic rate of fertilizer application cannot be up to the point at which it just returns enough to pay for its own cost, as is the case of farmers in a strong capital position. A farmer with limited capital must decide the place fertilizers can play in his farming business, and in making his decision, fertilizers will compete with other alternative expenditures. If he is realistic, he will use fertilizer to the extent that a dollar invested in fertilizer will make a return equal to the next best competitive enterprise. On the other hand, a farmer is not always realistic. He has personal preferences just like the rest of the population. If beef cattle are a part of his farm business, he may prefer to spend money on improving his herd by purchasing an expensive bull rather than purchasing more fertilizer for his pastures and crop land even though the latter would be best use of his limited capital. He may even borrow money for fertilizer and decide, after consulting with his wife, to remodel the kitchen, buy a new car, or television set.

When enough capital to fertilize all the acres of a given crop at the most profitable rate is not on hand and cannot be borrowed, the question arises as to how best to use what capital is available. Should he fertilize all the acres at a reduced rate, or fertilize part of the acres at the most profitable rate and use none of the remaining acres? Again the Economist has studied this problem and arrived at an answer.

In general it will be more profitable for the farmer to fertilize all his acres of the crop at less than optimum rather than to leave some acres unfertilized. As years go by and the farmer accumulates capital by plowing back returns from investments producing a high rate of return per dollar spent, he will obtain sufficient funds to fertilize all his acres at the optimum rate. The optimum rate, of course, will provide the greatest net returns. Only when a farmer lacks capital will it pay him to apply less than the optimum rate to all his acres.

The words "in general" were used in stating that it would be most profitable, lacking capital, to fertilize all acres at a rate less than optimum. Of course there are exceptions. If, for example, a farmer plans on planting alfalfa on 50 acres and soil test calls for 2½ tons of lime and 400 pounds of 3-12-12 mixed fertilizer per acre, to be put down before planting, it would be foolish for him to use less. If he can't afford to buy 125 tons of lime and 10 tons of 3-12-12, he had better cut the acreage to be planted to fit the fertilizer and lime he can afford to purchase.

The same principle would apply to land to be put down into permanent pasture. ◄◄◄

[1] Slusher, M. W., 1955. Enterprise costs and returns on rice farms. Arkansas Agricultural Experiment Station Bulletin 549.

ONE OUT OF EVERY TEN!

One tenth of the standing timber in the United States is made up of trees either rotten, or crooked, and much hardwood timber is inferior in quality, according to the U. S. Forest Service.

TEN TOP POINTERS FROM TOP TEN TOMATO CLUB

- **Select well-drained field, well supplied with organic matter. Do not plant tomatoes in same field more often than once in 4 years.**
- **Have soil tested to see if lime is needed and to obtain some indication of fertility level.**
- **Plow early, or in the case of direct-seeded tomatoes, fall plowing is necessary.**
- **Use ample amounts of fertilizer—1000 pounds or more per acre of 4-16-16 or equivalent is used by successful growers.**
- **If manure is available, apply it to land intended for tomatoes.**
- **Select good variety, plant at right time, and give plants a boost at planting time by using a starter fertilizer in the transplanter water. Select fertilizer high in phosphorus.**
- **Aim for 100% stand in field. This helps reduce costs.**
- **Follow a sound disease and insect control program. This may require at least 5 fungicide applications to control foliage diseases.**
- **Work with picking crew. Consider paying bonuses for high grades of U. S. No. 1 tomatoes.**
- **Observe timeliness and management throughout season. Aim to get job done on time. Hope for a "break" with the weather. The weather becomes less of a factor, however, as more attention is given to these points.**

TAKES GOOD PRODUCTION PRACTICES

LIKE most vegetable crops, successful production of tomatoes for processing depends on *many* practices —and not on a single factor.

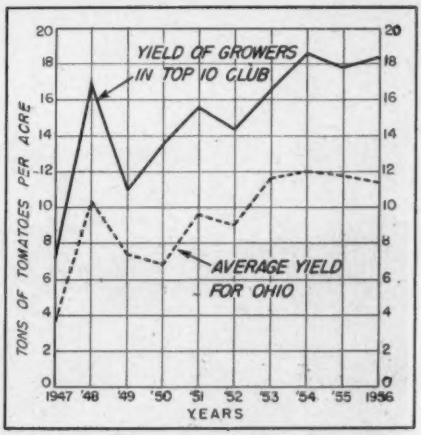
A look at the production reports of the growers in the Ohio Top Ten Tomato Club points this out very strikingly.

The Ohio Top Ten Tomato Club has been operating since 1947—sponsored by the Ohio Canners Association, the Baltimore and Ohio Railroad, and Ohio Agricultural Extension Service—to recognize growers who do a good job in producing tomatoes for processing.

The Ohio club is unique in that the "Ten" in the name refers to *upper ten per cent* rather than ten tons.

Mr. E. C. Wittmeyer, extension specialist in Vegetable Crops at Ohio State University, was born on a vegetable farm near Cincinnati. He earned his B.S. in Horticulture from Ohio State. And after doing a year's graduate work there, he joined American Agricultural Chemical Company as a specialist in their Soil Service Division. From there, he joined Ohio State.

TO BE TOP TOMATO GROWER


YIELD OF GROWERS IN TOP 10 CLUB
AVERAGE YIELD FOR OHIO
TONS OF TOMATOES PER ACRE
YEARS
1947 '48 '49 '50 '51 '52 '53 '54 '55 1956
0 2 4 6 8 10 12 14 16 18 20

Comparison of yields of growers in Ohio Top Ten Tomato Club, with average yield for Ohio—1947-56.

Growers with yields in the top per cent of all growers contracting with participating processors are honored. In 1956, 147 growers received certificates from their processors for being in the top ten per cent. Altogether, 1610 certificates have been presented since 1947.

The 1956 club growers raised 1740 acres of tomatoes—or nearly 10 per cent of all tomatoes raised by the participating processors. About 17,000 acres are raised by the growers contracting with processors participating in the program.

The average yield for 1956 Club Members was 18.31 tons per acre. The yield for all tomato growers in Ohio in 1956 was 11.6 tons.

By E. C. Wittmeyer

Extension Horticulture

Ohio State University

Production reports, filled out each fall for the various processors, are summarized for use in crop canning schools, statewide meetings, newspaper and radio releases, and by field men working with growers.

The yield of processing tomatoes in Ohio has grown about 80% since 1947. The average yield for 1943-46 was 6.4 tons per acre, compared with 11.8 tons for 1953-56. Many industrial leaders attribute much of this increase to the interest and enthusiasm of growers participating in this recognition program.

Drainage—A Big Factor

These top growers pay close attention to soil management practices. They know tomatoes require a well-drained soil with enough organic matter to help it retain moisture during the latter part of the growing season. In 1955, nearly nine out of ten growers producing high yields did it on well-drained fields. So did the high producers of 1954.

Table I summarizes this basic fact of tomato production.

Admittedly this interpretation of drainage is a matter of opinion, but for experienced field men and veteran growers it is a reliable evaluation.

Ohio tomato growers are including more sod crops and cover crops in rotations. A common practice is to topdress the sod or apply part of the fertilizer on the rye cover crop as this grower is doing.

MORE SOD CROPS AND COVER CROPS IN ROTATIONS

Table I.—Drainage Characteristics of Fields Selected by Top Ten Tomato Club Growers

Drainage	Per Cent of Growers		
	1954	1955	1956
Good to very good	79	88	91
Fair	20	12	9
Poor	1	0	0

Legume—Sod Crop Important in Rotating

In 1956, 47% of the growers had a sod crop immediately preceding tomatoes. More important was the rotation followed by the growers. The record summary shows that 87% of the growers had a sod crop *some place* in the 3-year rotation. One third of the growers (35%) had *2 years of sod* immediately ahead of tomatoes. Tomato growers know very well the important effects soil organic matter has on soil aeration, soil drainage, moisture relationships, and nutrient sources.

Table II.—Rotations Followed by Growers in Ohio Top Ten Tomato Club, 1956

Rotation 1954	1955	1956	Number of Growers	Yield
C	C	T	15	17.43 Tons per acre
C	S	T	17	18.21 " " "
S	C	T	59	18.07 " " "
S	S	T	52	18.92 " " "

Note: C = cultivated crop other than tomatoes.
S = sod crop like alfalfa, clover, meadow, etc.
T = tomato

In 1947, first year of the project, only 38 per cent of the growers followed a sod crop with tomatoes compared with nearly 50 per cent ten years later.

WIDER ROWS FOR EASIER CULTIVATION AND FERTILIZING

A uniform stand of plants is necessary for high yields. The trend in Ohio is toward wider rows. The tomatoes shown are planted in rows 6 feet apart. Wide rows facilitate late cultivations, make sidedress application of fertilizer easier, and aids harvesting.

Soil Testing Pays Off

Soil testing is practiced by many vegetable growers in Ohio. The Soils Laboratory maintained by the Agricultural Extension Service at Ohio State University tests several thousand samples each year for commercial vegetable and potato growers.

In 1956, 82 of the 147 club growers had their soil tested by some agency—either Ohio State University, the processing company's own laboratory, or some outside laboratory like a fertilizer company, private laboratory, etc. Growers who had their soil tested produced 18.61 tons per acre. Growers who did not have their soil tested produced 18 tons per acre.

Many processors have all the fields of their contract growers tested. But soil tests in themselves are valueless unless growers apply the recommended plant foods.

Fertilizer Use Increasing

Ohio growers producing these high yields use more fertilizer now than ten years ago.

Average basic fertilizer application lbs/A			
	N	P_2O_5	K_2O
1948	21	74	70
1956	34	112	106

These figures refer to basic fertilizer application and do not include the fertilizer applied as a sidedress application. *A 20-ton crop will remove in the fruit alone about 120 lbs. N, 40 lbs. P_2O_5, and 160 lbs. K_2O.*

Method of Fertilizer Application

The growers apply their fertilizers in many different ways, as shown in Table III. The "drill only" method is by grain drill after plowing. Some of the growers apply the fertilizer before plowing, known as "plow down."

And others apply by "sidedress," which means along sides of row after plants are set in field.

Table III.—Methods of Fertilizer Applications and Average Yields of Growers with Different Methods.
Ohio Top Ten Tomato Club—1956

Method	Number of Growers	Average Yield
Drill only	50	17.79 T.
Plow down only	29	18.63 T.
Plow down plus drill in	25	19.10 T.
Plow down plus sidedress	13	18.12 T.
Drill plus sidedress	16	18.24 T.
Other combinations	9	–

The experiences of both growers and official experiments indicate part of the fertilizer for tomatoes should be applied deep. How important yield figures are in a study of this nature is questionable, but for the last 3 years the plow-under application method produced some of the highest yields.

Virtually all growers use starter fertilizers in the transplanter water when putting out transplants. In 1956, only one grower out of the entire group did not use a starter fertilizer in the transplanter water.

This practice, which costs little, pays off in better stands. It gets plants established earlier, causing earlier maturity. The analyses used by Ohio growers are high in phosphorus—such as 10-52-17, 15-30-15, and similar ones.

The usual application is 3 pounds of 10-52-17 per 50 gallons of water, with about 150-200 gallons per acre—or 9 to 12 pounds of 10-52-17 per acre.

Many other practices are summarized by the Club participants. Among them are the ten important practices presented, step by step, at the outset of this article. They represent a composite opinion from top Ohio growers producing 15,548 acres of tomatoes for processing on 1,610 fields over the past 10 years.

And they are worth heeding—if you want to be a top tomato grower.

◄◄◄

Seven Steps Toward Conservation

Three inches of topsoil, it has been said, stand between man and oblivion. If that is true, then these seven steps suggested by Illinois agronomists for controlling and cutting losses of topsoil and water apply to virtually every farm in the land:

• Treat the soil. Apply limestone and fertilizer as needed. The more you build up the productivity of the fields in grass and legumes, the greater will be the protection from erosion. Luxuriant plant cover and rich organic matter hold the soil in place.

• Use rotations that include grasses and legumes. Grow these crops often enough to keep soil losses at a safe, low level.

• Manage crops in a way that will reduce erosion. Good management includes disking down stalks in the fall and moderate grazing of grain and pasture.

• Farm on the contour. This not only helps hold soil, but increases yields.

• Combine strip cropping or terracing with contouring on slopes too long or too steep for contouring alone.

• Provide grass waterways and outlets to remove runoff.

• Improve soil drainage. Establish good root systems and install tile systems where needed.

"These steps," say the agronomists, "are essential for continued profitable farming on your land."

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FOR BETTER SOILS

FERTILEGRAMS

Fall seeding season is an ideal time to establish contour strip crops, according to Frank Doggett, soil conservationist for the N. C. Agricultural Extension Service.

Contour strip cropping is a pattern of farming in alternate contour bands of close-growing and till crops. In many ways it is the most satisfactory means of erosion control available to farmers, declares Doggett. It protects against both water and wind erosion. It can be used on sandy and shallow stony soils where terracing is not practical. It is also used on slopes too steep for terraces and on land so nearly level that terraces are not necessary. It is generally used without terraces, but on extremely erodable soils it may be used with terraces.

Contour strip cropping is simply a good soil conserving rotation established in contour bands rather than fields. It has many advantages: once established it makes a rotation simple and easy to follow. It costs nothing to establish and provides no obstacles to farm machinery. No more land is required to farm land in a given rotation in strips than in fields.

A fall application of three or four pounds of 3-12-12 fertilizer to every 100 feet of row will benefit the growth of strawberry plants for improved crop prospects next spring, say Purdue University horticulturists.

We are squandering our agricultural soils. D. A. Williams, Soils Administrator, U.S.D.A., writes: "The Soil Conservation Service estimates that more than seventeen million acres of the best farmlands have been converted to non-agricultural uses in the last fifteen years. Projection of the present rate indicates that an additional 27,000,000 acres of productive land will be withdrawn from agriculture by 1975. Once buried under steel or concrete, productive land, for all practical purposes, is never again available for agricultural production. Temporary surpluses of some crops tend to cloud the fact that some day we will need every acre of our best land to feed and clothe our growing population.

A boom in reforestation is on in Louisiana. State Forester James Mixon reports that Louisiana landowners have ordered 90 million pine tree seedlings this season.

All this adds up to a lot of pine trees, and a lot of reforestation, especially when the seedlings grown in private nurseries and the natural reseeding where seed trees have been left are considered. It has been sparked in part by a growing realization among landowners of the value of trees.

The price of timber, like other prices, has its ups and downs. But the long-range trend is certain to be up, as the population increases.

A shortage of potash in the vines may be connected with the serious black spotting problem in Russet Burbank potatoes, say plant scientists at the University of California.

The internal stem-end spotting or bruising, a problem of potato producers in the Santa Maria and Salinas valleys, has also been found recently in the Bakersfield area of the San Joaquin Valley.

Laboratory and field tests showed that the blackening occurs only after potatoes are handled, and that mature potatoes are the most seriously affected. But in all cases, the occurrence of black spot is closely associated with potassium nutrition, reports John W. Oswald of the

FROM ACROSS THE LAND

FOR BETTER CROPS

Berkeley campus and Oscar A. Lorenz, vegetable crops specialist at Riverside.

The scientists made tests in three fields where potash was plentiful, found little or no black spotting in potatoes that were machine-dug or artificially bruised in a barrel seed treater.

In three other fields where the potash supply was low, internal black spot was severe. Addition of potash fertilizer to these fields reduced both the amount and severity of the black spotting.

The scientists believe that potatoes obtaining sufficient potassium from the soil for normal vine growth and yield may still lack enough of the element for proper development of the tubers themselves.

Strawberries should be given some sort of ground cover or mulch to protect the plants during the winter, according to Professor George L. Slate, small fruit specialist at Cornell's New York State Experiment Station at Geneva.

Mulching prevents the plants from heaving due to frost action and protects them from severe cold, says Professor Slate. The protective cover should be in place by December 1st, he states.

Various mulching materials have been tried in the Station plantings. Straw and marsh hay have given good results when used to a depth of three to four inches. Sawdust applied to a depth of two to three inches has proved satisfactory. On soils of low fertility, however, it is advisable to add a nitrogen fertilizer in the spring where sawdust has been used, advises Slate.

For home plantings a covering of leaves will give satisfactory protection, providing the leaves are used only to a depth of two to three inches. Too heavy an application may lead to matting of the leaves and smothering of the strawberry plants.

Mulching should be done before temperatures drop below 20 degrees, but not until the plants have been subjected to several hard frosts, explains the Station fruit specialist.

When the strawberries start to grow in the spring, part of the mulch should be removed and placed between the rows. There it will discourage weed growth, will keep the soil surface cool and moist, and will help keep the berries clean.

Weeds may do a big part of their damage within a month after crop plants emerge from the ground. At least that's the case with carrots, beets and onions, say Wisconsin horticulturists. Farmers have long known that timely weed control is important. This research backs up that opinion.

In Missouri virgin soil cropland, only 50 to 60 bushels of corn per acre were produced. Adjoining fields, cropped for many years but properly fertilized, returned 80 to 100 bushels per acre.

Have your soil tested in fall if you want to find out how to fertilize your fields for best yields next year, advises Paul Carson, associate agronomist at South Dakota State College Agricultural Experiment Station.

By testing your soil in fall, you will have ample time to have the samples analyzed, get the results and recommendations from Experiment Station scientists, and order your fertilizer when supplies are plentiful. Three other advantages of fall testing are that crop yields on your fields are fresh in your mind or can be observed, you are not so busy as during the spring, and you can collect samples behind the plow during fall tillage.

REVIEWS

November, 1957

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COVER CROPS . . .

AN ALLY

AGAINST SOIL COMPACTION

CAN cover crops be an ally in the farmer's fight against soil compaction?

Plant and soil scientists at the University of California, Davis, hope this question will be answered by current experiments with 15 different kinds and combinations of cover crops.

These experiments are part of the University's statewide research program to study causes and cures for soil compaction, a farm problem of ever-increasing importance.

William J. Flocker, vegetable crops specialist at Davis, is testing the cover crops to determine which ones remove the most moisture from the soil. He is also checking their differences in such factors as root penetration and the amount of organic matter they contribute to the soil.

Flocker is testing the crops on three different plots, each having soil compacted to a different degree. Seed beds on the three plots were prepared by double disking and harrowing, but two of the plots were subjected to artificial compaction before cultivation.

Heaviest compaction was obtained by running a jeep back and forth across the plot, then doing the same with a tractor. On this plot, the surface soil remained in large clods after cultivation, and water infiltration was limited to .11 inches in three hours.

On another plot, compacted by a tractor alone, surface clods were smaller and fewer in number, and water infiltration was measured at 1.13 inches in three hours.

A third plot was not compacted at all by artificial means, and it formed a good seedbed with almost no clods after cultivation. Moisture penetration here measured 4.93 inches in three hours.

Among the crops Flocker is testing are sweet clover, purple vetch, horse bean, barley, oats, rye, and such combinations as vetch and barley. Some of these, it is hoped, may prevent compaction in soils that are still loose. Others may alleviate existing compaction.

Results of the cover crop tests at Davis will be further checked at test plantings in various parts of the state. Also, they will be compared with findings from other experimenters, who are seeking a soil compaction cure through such means as mechanical devices, soil additives, and new irrigation techniques.

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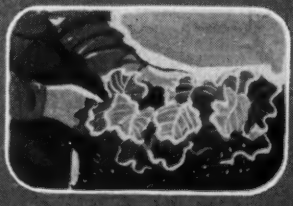

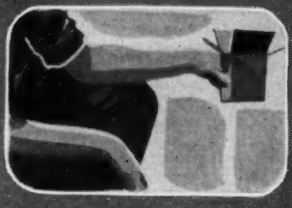

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Potash Helps Control Pasture Weeds, Raise Production

Doll, E. C.

Potash applied to farm lands. . . Croplife 4(20):14. May 20, 1957.

Potash supplied to farm lands in Muhlenberg County, Kentucky, low in this element helped keep down weed content in a pasture experiment and also raised production. Potash applications were made on an orchardgrass—tall fescue—ladino clover pasture mixture. About 400 lb. per acre KCl raised forage production 2,700 lb. above the no-K test plots; likewise, higher K applications tended to bring more clover and grass in the test fields, cutting weed and weedy-grasses content. Potash applications were varied to check pasture response. Results were as follows: no K Plots, 2800 lb. dry matter per acre in 3 cuttings, with about ⅓ of this consisting of weeds, etc.; with 100 lb. 60% KCl, 4300 lb. dry matter per acre; 200 lb. 60% KCl, 5300 lb. dry matter; and 400 KCl, 5500 lb. dry matter.

NPK Movement in Potatoes

Kushizaki, M.

The physiology of potatoes. 1. Absorption and translocation of inorganic elements by the plants. Res. Bul. Hokkaido nat. Agric. Exp. Sta. No. 72, 72-81. 1957. Abs. Soils & Ferts. 20(4):1473. Aug. 1957.

Total N, P and K contents increased until flowering and then decreased in leaves and stems and increased in tubers. 105 days after planting when the leaves were yellow, the tubers contained 65% of the total N and 75% of the total K. At primary leaf development, 43 days after planting, the amounts of NPK were about the same as in the seed potato at planting and the Ca content was about 10 times greater; the amounts of NPK (as a percentage fresh wt.) were ⅓-¼ of their initial amounts and the amount of Ca was 4 times greater. The elements present in the seed potato at planting are important in early growth.

Factors Influencing Potash Leaching

Gammon, N., Jr.

Leaching of potassium salts. Fla. Agr. Exp. Stas. Ann. Rept. 1956, p. 131-132. 1956.

Relative rates of leaching of K from KCl, K_2SO_4, and K_2CO_3 were studied in the laboratory. Soils studied retained more K from K_2CO_3 but this material proved impractical for general use because even moderate rates of application resulted in a breakdown of soil organic matter. Slightly more K was retained by the soil when KCl was used than when K_2SO_4 was employed. This difference does not appear to be large enough to be important from the fertilizer standpoint. Percentage of K retained from an application of a K_2O salt seems to depend upon the amount of salt applied, the base saturation (soil pH) and the base exchange capacity of the soil. Higher exchange capacities and higher soil pH values, at least up to pH 6.2, increase K retention. Potash retention from K salt applications within the practical ranges of fertilizer usage has varied from less than 10 to over 50% in laboratory tests where 6 inches of soil were leached with the equivalent of at least 5 inches of water. Over 90% of the anions from K fertilizer salts, as evidenced by chloride or sulfate, is leached out of the surface 6 inches of soil by the equivalent of 2½ inches of rain passing through the soil under laboratory conditions. Field studies will be necessary to determine to what extent soil type differences, especially hardpans and clay layers, influence the rate of leaching from Florida soils.

Some Texas Areas Need Potash for Alfalfa

Staten, R. D.

Alfalfa production in Texas. Tex. Agr. Exp. Sta. Bul. 855, p. 11-12. April 1957.

Most of the alfalfa soils in Texas have considerable K, or K_2O, and K deficiencies in alfalfa are seldom reported. However, large amounts of this important plant food are needed now in some areas of East Texas and eventually may be needed in other areas where alfalfa is continually being removed as hay. Soils from alfalfa fields should be tested at least every three years to determine the need for mineral elements. Top-dressings of the deficient elements should be applied annually because each ton of alfalfa hay removes about 12 lb. P_2O_5, 45 lb. K_2O and approximately 100 lb. of lime from the soil.

Potash-Nitrogen Teamwork
Dhar, N. R. and Ghosh, S. K.
Nitrogen loss in soils on the application of nitrogenous compounds and its retardation by the addition of potassium chloride. Proc. Nat. Acad. Sci. India 24A, 219-224. 1955. Abs. Soils & Ferts. 20(2): 628. April 1957.

In laboratory tests conducted under aerobic conditions in light and darkness, over 50% of the N given to the soil as $(NH_4)_2SO_4$ or urea were lost in 15-60 days due to the formation and easy decomposition of NH_4NO_2. The N losses were progressively decreased with increasing rates of KCl leading to the formation of the more stable KNO_2 and its oxidation to KNO_3.

Potash Reduces Blackspot Damage in Potatoes
Lorenz, O. A., Oswald, J. W., Fullmer, F. S., et. al.
Potato fertilizer and blackspot studies Santa Maria Valley—1956. Calif. Univ. (Davis), Dept. Veg. Crops, V. C. Series 88, 28 pp. Feb. 1957.

Results from six field experiments with potatoes in the Santa Maria Valley provided the basis for some tentative fertilizer recommendations. P will give responses in only a few soils and an application of 50 to 100 lbs. of P_2O_5 per acre should be sufficient. K_2O should be included in most fertilizers. Applications of 100 to 200 lbs. of K_2O are recommended; on soils known to be deficient in K the higher rate should be used. About half the fields sampled were very low in K. The application of high rates of K fertilizers significantly reduced but did not effectively control blackspot. The severest blackspot was in those experimental fields where the yield response to K was greatest, where K levels in plants were low, and where K deficiency symptoms appeared in the vines. A survey of 25 fields showed that tubers from fields where the plants analyzed high in K had less blackspot damage than tubers from fields where plants analyzed low in K.

Fertilizer Placement Affects Yields
Fertilizer waste in application. USDA Soil Conservation 22(9):216. April 1957.

Crop yields are directly affected by the way fertilizer is applied, according to tests made by soil scientists at Michigan State University. In muck soil tests, they found that method of application made as much as 103% difference on onion yields and up to 50% on spinach yields. From the research it was concluded that fertilizers for these two crops should be placed in a band two inches below the seed level or in a band one inch to the side and two inches below the seed level. If more than 800 lbs. per acre of a fertilizer such as 5-10-20 is to be applied with row spacing of 16-18 inches, the excess should be put on ahead of planting with a fertilizer grain drill, be broadcast on the surface, or plowed under.

Fertilizer Affects Tobacco Taste
Fujiwara, A. and Kurosawa, M.
The biting taste of Burley Tobacco leaves (nutrition of Japanese tobacco). 2. Effect of soil and fertilizing on taste with special reference to phosphate. Tohoku J. Agric. Res. 7. 199-207. 1956. Abs. Soils & Ferts. 20(3):1138. June 1957.

In pot experiments with tobacco, P and K applications markedly improved growth and ripening, increased the soluble sugar/total N ratio and lessened the taste. In cooler parts of Japan heavy P and K applications are recommended.

New "Fused" Fertilizer Materials
Terman, G. L. and Stanford, G.
TVA discusses new "fused" fertilizer materials. What's New in Crops and Soils 9(7):25, 1957.

Two fused K phosphates have been produced in experimental quantities by the Development Branch of TVA on a pilot plant at Wilson Dam. These new high-analysis fertilizers are being compared with KCl (0-0-60) in experiments as sources of K for alfalfa, ladino clover, and corn. In a "fused" material, different fertilizer nutrients or compounds are combined as the result of a heating process. One fertilizer (0-49-33) is largely potassium metaphosphate, of which a large portion of K is water soluble or quickly available to the plants. The second fertilizer (0-42-29) is largely potassium calcium pyrophosphate. The K in it is very slowly soluble in water. Such fertilizers that are low in water-soluble K may also reduce "luxury" or excessive consumption of K by legumes. Laboratory studies indicate that less K is lost from fused materials through leaching in sandy soils than from KCl. Although experiments indicate that K is about equally available to alfalfa and corn in both the fused materials and in muriate, results from field experiments may be quite different. In short-term tests in the greenhouse, absorption of K by corn in 72 hours was much lower from the fused materials than were low in water-soluble K.

Complete Plant Food Recommended on Oats and Wheat
Thompson, W. R.
Extra plant food on pastures means additional cash in bank. Croplife 4(28):6. July 15, 1957.

Through tests at Southwestern experiment stations it was found that P and K were necessary for good fall growth of winter grazing from oats and wheat. These plant foods were once thought not too necessary for grain production and only N on low P and K soils, even though ample N was used, the station men began to study what caused the poor growth even though N was present. Now a complete plant food is recommended for small grain for fall and winter grazing and the results are quite different from what they were when P and K were not used.

An Australian was trying to impress a Texan with the wonders of his country but then the Texan saw a kangaroo. Drawled the man from the Lone Star State: "A'll grant you one thing, that's for sure. Your grasshoppers are bigger'n ours."

• • •

Sam had backslid again, and his pastor was upbraiding him for it. "Why didn't you say, 'Get behind me, Satan'?"

"I did say dem very words, parson," Sam replied. "Den Satan he say, 'All right, Sam, I'll git behind. Since we bofe goin' de same way, hit mek no dif'unce who takes de lead.'"

• • •

An old millionaire invited his three sons and their wives to a Sunday dinner. As they sat down at the table, he explained his reason for bringing them all together. "I am getting old," he said, "and yet I have not made out my will. Why? Because of my disappointment at not yet being a grandfather." He said he planned to make his will and as a bonus, he would give $50,000 to the first grandchild.

Then he bowed his head and asked the blessing. When he looked up, he found he was the only one left at the table.

Two fellows were discussing the chances of henpecked husbands.

"But let me tell you," said one, "I'm boss at my house. Last night I found there was no hot water. So I raised the roof. Believe me, I got hot water, too—and in a hurry!" There was a pause, and he added: "I hate to wash dishes in cold water, don't you?"

• • •

"Why is a bustle like a historical romance?"

"I'll bite."

"Both are fictitious tales, based on stern reality."

• • •

Three old cronies were discussing the funeral of a friend who was dying, in the latter's hearing. Economy was essential and this led the first to suggest they should do without a third carriage. The second agreed, and the third said: "Cut out all the carriages and flowers; we'll just have the hearse." A tired voice from the bed intervened: "If you give me my trousers, I'll walk."

• • •

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